# COMPARISON OF AVIAN SPECIES DIVERSITY AND DENSITIES ON NON-MINED AND RECLAIMED SURFACE-MINED LAND IN EAST-CENTRAL TEXAS

A Thesis

by

DAWN NICOLE WENZEL

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2006

Major Subject: Wildlife and Fisheries Sciences

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Approved by:

Chair of Committee, Nova J. Silvy
Committee Members, R. Douglas Slack
Fred E. Smeins
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# ABSTRACT

Comparison of Avian Species Diversity and Densities on Non-mined and Reclaimed Surface-mined Land in East-Central Texas. (August 2006)

Dawn Nicole Wenzel, B.S., Texas A&M University

Chair of Advisory Committee: Dr. Nova J. Silvy

Surface mining often changes the native landscape and vegetation of an area. Reclamation is used to counter this change, with the goal of restoring the land to its original pre-mined state. The process of reclamation creates early successional-stage lands, such as grasslands, shrublands, and wetlands, attracting new plant and animal species to the area. I compared avian species density (number of individuals/ha), diversity (H'), and richness (number of species/ha) on reclaimed and non-mined lands at TXU's Big Brown Mine in Fairfield, Texas. I also compared my results to those of a previous study conducted 25 years earlier. Avian counts were conducted using a fixed-radius point-count method on 240 points placed in four different vegetation types and in four land-age groups (time since being reclaimed). Vegetation was measured both locally, and at a landscape level. Overall bird species density did not exhibit a clear relationship on non-mined versus reclaimed land. Overall bird species diversity was greater on non-mined lands, whereas overall species richness was greater on reclaimed lands. My results demonstrated a lower mean/point bird density and higher mean/point bird diversity than were found 25 years earlier. Different nesting guilds occurred on the reclaimed lands than occurred on the non-mined lands. Results suggested different species were attracted to the several successional stages of reclaimed lands over the non-mined lands, which consisted of climax vegetation. The different successional stages of reclaimed lands increased overall diversity and richness of the landscape as a whole. Five bird species of conservation concern were observed in the study, all of which occurred on reclaimed land. Four of the five species primarily occurred on reclaimed lands. Future land management should include conserving different successional-stage lands to increase overall biotic diversity and richness of mined land, preserving reclaimed habitat for species of concern, and educating future private landowners on the importance of maintaining vegetative and bird species diversity.

I dedicate this thesis to my parents, Mary and Larry Wenzel. Their love and support has been a stronghold throughout my life.

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Finally, thanks to my parents for their support and encouragement, and to my friends for helping to take care of things at home while I was gone. For those I have forgotten to mention I apologize. So many people helped this project come together and I thank all of you.

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# INTRODUCTION

## Background

Surface mining for lignite coal changes the physical landscape, natural vegetation structure and composition, and may alter wildlife species present in that area (Gorsira and Risenhoover 1994). To counter the environmental changes caused by surface mining, mining companies often implement reclamation procedures, as required by law, to restore the land to its original contour and condition for the benefit of wildlife, or for other purposes, such as ranching and agriculture (Rhodes et al. 1983, Scott and Zimmerman 1984). However, restoring an area to its original condition (mature forests and oak savannahs) may take a long time (Gorsira and Risenhoover 1994). Post oak (*Quercus stellata*), for example, is a major vegetative component in the study area, but when this species is disturbed it is slow to establish and mature, impeding re-establishment of pre-mining condition. Herbaceous and shrub species planted in reclaimed areas to control erosion and stabilize soil create an early successional shrubland savannah in place of the native non-mined forest or tree savannah. This intermediate shrub environment may provide habitat for wildlife species not present on non-mined areas (Rhodes et al. 1983). In addition, the planting of reclaimed areas with species not present on the non-mined site (Gorsira and Risenhoover 1994) may create a different vegetation composition and structure, thus providing habitat for wildlife species not originally found on the area. Areas not mined (i.e., streams, cemeteries) within the reclaimed area provide habitat for many of the original bird species. Impoundments

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This thesis follows the style of The Auk.

created to control erosion also provide additional wildlife habitat and for these reasons bird diversity on the reclaimed areas may be greater than on the non-mined areas.

*Previous studies*.—Several previous studies have evaluated wildlife populations on reclaimed areas; however, I will consider only those that describe avian species diversity and densities. Krementz and Sauer (1982) working in Wyoming, found 2–3-year-old reclaimed areas exhibited low bird diversity with high densities, while non-mined areas contained high diversity, and low densities. Brenner and Kelly (1981) studied 20-year-old reclamation sites in Pennsylvania, finding avian species varied as the vegetation successional stage changed. They suggested reclaimed land be planted with diverse vegetation to stabilize the area and provide cover for wildlife, allowing native vegetation to reestablish in the area. They hypothesized such a reclamation scheme would provide several successional stages, which in turn would increase bird species diversity in the area. Although this reclamation practice may not provide habitat immediately for species present on the non-mined area, disturbance-dependent species which were not common to the area before, such as grassland birds, may invade. This increases species diversity in the overall landscape (Allaire 1978, Brenner and Kelly 1981).

*Grasslands*.—Reclaimed mined lands may destroy habitat for some species, but the process also may create habitat for species not found on the non-mined area. Surface mining disturbs the landscape creating lower-successional stage ecosystems, such as grasslands (Bajema et al. 2001). Native grasslands have declined throughout the state and nation for the last 150 years from conversion to agricultural or non-native pasture land, or from shrub invasion due to fire suppression (McPherson et al. 1988, Bajema et al. 2001, Ingold 2002). With loss and fragmentation of grassland habitat, many species dependent on this habitat have declined as well (Ingold 2002). The areas of recently reclaimed surface-mined land create a refuge for grassland species (Ingold 2002), many of which are species of concern, such as the Dickcissel (see Appendix A for scientific names of all bird species observed in the study). Dixon (2004) studied the nesting ecology of Dickcissels on reclaimed lands at the TXU Big Brown Mine. He found Dickcissels to use reclaimed habitats in an early successional stage over more mature non-mined habitats. Several grassland species, such as Henslow's Sparrow, are sensitive to habitat fragmentation and will not occur in habitat patches smaller than 10 to 50 ha. Therefore, these tracts of newly created grassland provide habitat for this sparrow (Bajema and Lima 2001, DeVault et al. 2002). Whitmore (1980) suggested that larger tracts of land be mined at one time as he found reclaimed grasslands larger than 40 ha were more stable, had higher bird diversity and density and a lower species turnover rate (Whitmore 1980).

*Wetlands*.—Wetlands created through surface-mine reclamation provide valuable wildlife habitat as well. Over half of the wetlands in the United States have been lost to drainage or filling for agriculture and urbanization (Horstman et al. 1998). Reclaimed mining areas can provide refuge for wetland dependent species in providing appropriate habitat for many wading birds and waterfowl (Olson and Barker 1979, Horstman et al. 1998). Such areas often provide (1) islands with grassy upland nesting sites for geese and ducks; (2) interspersion of open water and submersed and emergent vegetation for loafing and feeding; (3) shallow feeding areas for wading birds; and, (4) large open lakes for molting and staging areas (Perkins and Lawrence 1985). Sediment ponds on Big Brown Mine are known to support several species of non-breeding waterfowl (Elser 1988, Reynolds 1989, and DeRoia 1993). Vegetation on these ponds provided cover and food resources needed by these bird species throughout the fall and winter. These sediment ponds also support several species of wading birds which depend on the ponds for food resources (Renfrow 1993). McKnight (1991) transplanted wetland soil and planted wetland vegetation around newly created sediment ponds on Big Brown Mine creating a diverse wetland community. These ponds supported many more bird species dependent on wetland areas for survival. If managed correctly, these newly created wetlands can help compensate for the loss of natural wetlands throughout the nation (Horstman et al. 1998).

*Determining reclamation goal*.—As described above, several studies contend that surface-mine reclamation has both advantages and disadvantages for wildlife species. Reclamation usually alters the native habitat for species present on non-mined land, yet creates habitat for species not traditionally present on the land, increasing species diversity over the entire area (Brenner and Kelly 1981). However, if species of concern, such as the Dickissel and the endangered Interior Least Tern, are present on recently reclaimed land, should this early successional stage be maintained through continued disturbance? Conversely, species of concern may exist on non-mined areas, justifying reclamation to return a mined area to the condition of its non-mined state. Whatever the case may be, the first order of importance in deciding the goal and effectiveness of reclamation is determining which species are present on the non-mined land and which species are and are not present on the different-aged reclaimed areas. This study hoped to accomplish this goal.

Only one study of bird species diversity and density has been conducted on TXU's Big Brown Mine, Freestone County, Texas. Cantle (1978), working on Big Brown Mine only 7 years after mining started, divided the reclaimed area into newly reclaimed, an area reclaimed from 1 to 3 years, and a non-mined area. He noted 22 of 42 species found on the non-mined area were affected by mining and reclamation, and species diversity was generally lower on reclaimed sites. However, he noted 14 species of the grassland guild which were positively affected by reclamation and flourished in those areas (Cantle 1978). Today on Big Brown Mine, a species specifically of note on the area is the endangered Interior least tern (Kasner 2004). In 1997, this species found suitable nesting habitat on an area prepared for reclamation (TXU Mining Company 2002). Big Brown Mine has now been in operation for more then 28 years and no work on general bird species diversity and densities have been conducted since Cantle's (1978) study. Reclaimed lands have matured and bird species and densities have probably changed considerably since Cantle's (1978) study. It is therefore logical to determine current bird species present and bird densities in the area and compare collected data to Cantle's results in order to determine the effect of past reclamation procedures on the avian community.

**Objectives**

The main objective of my study was to determine the effect of mining and reclamation on different bird species. More specific objectives were to (1) compare breeding avian species diversity, richness, and densities present in different vegetation types on both non-mined and reclaimed-mine land ($Ho_1$: Breeding avian species diversity and richness are equal on all vegetation types on non-mined and reclaimed mine-land; $Ho_2$: Breeding avian species densities are equal on all vegetation types on non-mined and reclaimed mine-land); (2) compare breeding avian species diversity, richness, and densities on various aged reclaimed-mine land (land reclaimed 0–5, 10–15, and 25+ years ago) ($Ho_1$: Breeding avian species diversity and richness are equal on all age classes of reclaimed mine-land; $Ho_2$: Breeding avian species densities are equal on all age classes of reclaimed mine-land); (3) determine "species of concern" on both non-mined and reclaimed lands; (4) compare the results of this study with those of Cantle (1978) and provide management recommendations for managing bird species on reclaimed lands ($Ho_1$: Bird density, diversity and richness observed during this study on lands reclaimed less than 5 years would differ from birds observed by Cantle (1978); $Ho_2$: Bird density, diversity, and richness observed during this study on lands reclaimed less than 5 years would be similar to those observed by Cantle (1978).

# METHODS

## Study Area

The study area for this project was the TXU Mining Company's Big Brown Mine, located in Freestone County, 16 km east of Fairfield, Texas. The mine site was located within the Post Oak Savannah ecoregion of Texas. Non-mined areas were 100–270 m above sea level and had a gently rolling topography (0–5% slope), while post-mined areas had slightly steeper slopes (0–15%). Average annual rainfall in the area was approximately 98 cm (Mersinger 1999). Dominant soil type throughout the mine was a clay-loam texture of the Axtell and Tabor soil series, containing a low amount of organic matter (McKnight 1991, Yao 1994). Mining and reclamation on the Big Brown Mine has taken place for the past 28 years (Gutierrez 2001). Mined lands were intensively reclaimed in accordance with the federal Surface Mine Control and Reclamation Act of 1977 (DeRoia 1993). Over 5,454 ha have been mined, and 5,328 ha have been reclaimed (Gutierrez 2001). Non-mined areas were composed of several habitats including improved pasture (57%), woodland (32%), old fields (8%), and riparian (30%) (Truett 1972, Renfrow 1993). Reclaimed areas consisted mainly of improved pasture (80%), reforested areas (16%), and water (4%) (Reynolds 1989, DeRoia 1993).

Six major vegetation types occurred on the mine area including improved pasture, upland hardwoods, reclaimed wildlife habitat areas, bottomland hardwoods, un-mined riparian stringers, and recently reclaimed areas (Mersinger 1999). Improved pastures, used for agriculture and grazing, consisted of mainly Bermudagrass (*Cynodon* *dactylon*) and clover (*Trifolium* spp.). Oaks (*Quercus* spp.) were the dominant woody vegetation in the upland hardwoods, along with a sparse shrub and herbaceous plant layer in the understory. The bottomland hardwood and riparian stringers consisted mainly of an oak and elm (*Ulmus* spp.) overstory, with several understory shrubs and vines. Reclaimed wildlife habitat areas were dominated by several planted woody species such as American sycamore (*Platanus occidentalis*), green ash (*Fraxinus pennsylvanica*), cottonwood (*Populus deltoids*), loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), oaks, switchgrass (*Panicum virgatum*) and other native bunch grasses, with a large amount of invasive willow bacchris (*Baccharis salicina*; Lady Bird Johnson Wildflower Center 2004). Recently reclaimed areas were dominated by Bermudagrass, and newly reclaimed areas had several areas of bare ground (Mersinger 1999, Huff 2001). In addition, over 150 sediment ponds also existed on the area, consisting of ponds constructed on both reclaimed (69%) and non-mined (31%) land (Renfrow 1993).

**Study Sites**

The mine area was divided into three major sections (Fig. 1). Area “A” consisted of land mined and reclaimed prior to 1980. Much of this area had been sold to private land owners and was used mainly for ranching. Most of this land was dominated by Bermudagrass and grazed at differing intensities depending on landowner management. Area “B” mine was no longer active and all areas had been reclaimed. Most of this land remained under TXU ownership and management, though a large area was sold to a local rancher in the second year of my study. A portion of this land was composed of

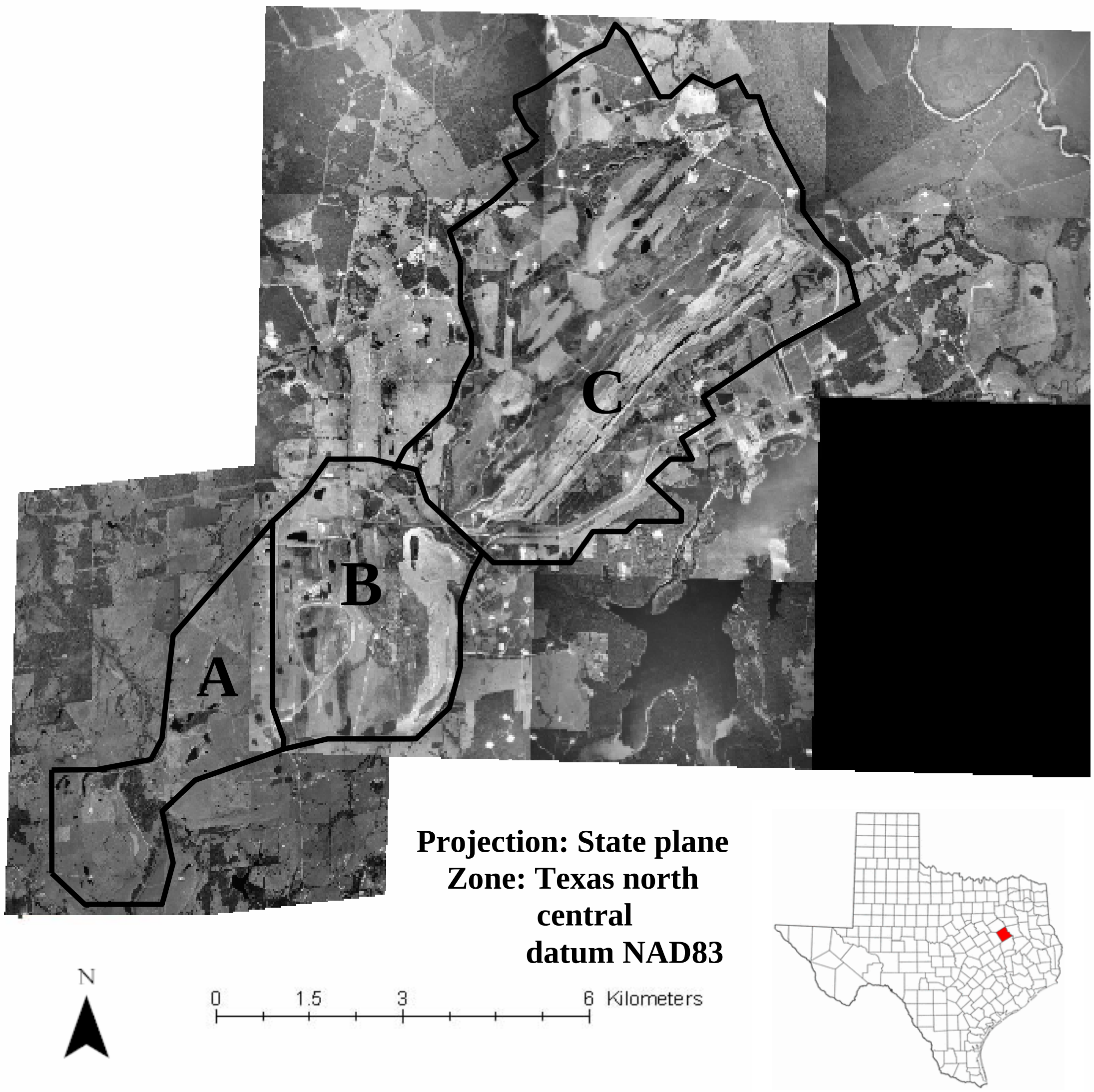



Fig. 1. Location of the A, B, and C mining areas of Big Brown Mine, Freestone County, Texas.

reclaimed wildlife areas but majority of the area was Bermudagrass hay pasture. Area "C" was the largest section with the only active mine pit. Reclamation in the area dated from the early 1980s to 2004. The "C" area also had the largest non-mined section. This section had the largest percentage of reclaimed wildlife habitat and was owned by TXU. This area also had a large amount of Bermudagrass pasture used for hay and cattle grazing.

**Experimental Design**

Four main vegetation types were sampled for bird species diversity and density in both the non-mined and reclaimed lands. These were pasture, bottomland forest, wetland, and upland forest. Vegetation type was determined by the dominant vegetation present and significant landmarks (ponds, creeks). Pasture areas consisted of mainly herbaceous groundcover (usually Bermudagrass) and had less than 40% woody species cover. Bottomland forest areas were near creeks or ponds in valley areas with greater than 40% woody species cover. Dominant woody species of the vegetation type were usually water oak (*Quercus nigra*), cedar elm (*Ulmus crassifolia*), American elm (*Ulmus americana*), cottonwood, and black willow (*Salix nigra*). Wetland areas were designated by areas in low elevations near creeks or ponds with less than 40% woody species cover. Herbaceous ground cover was dominated by wetland indicator species such as *Cyperaceae* spp., *Juncus* spp., *Carex* spp., and other wetland forbs and grasses. Upland forests consisted of greater than 40% woody vegetation cover with dominant woody vegetation such as loblolly pine, post oak, and eastern redcedar (*Juniperus virginiana*). In each vegetation type, I sampled non-mined land (control sites) and 3 reclaim age-class categories (in 6-year intervals) consisting of reclaimed 0–5 years ago, 10–15 years, and over 20 years ago. Therefore, plots consisted of 15 categories (Table 1). The reclaimed land was divided into age classes using boundaries provided by TXU employees (Fig. 2). Boundaries were determined by the date land was placed into a final reclamation land-use category (i.e., wildlife area, commercial forest, pasture), and overlaid onto an aerial photo of the area. Bird sampling points were selectively placed at random, 402 m apart, with consideration of accessibility, with the aide of aerial photos (Fig. 3). I also ensured points were placed in the areas of Cantle's (1978) original transects for comparability. As many points as possible were placed in each category for a total of 240 points sampled per season. Sampling was done during two breeding seasons for a total of 480 sampling points. Points were marked with flagging and a global positioning system (GPS) location taken for each. In addition, photos were taken north and south at each point and the status of the point recorded.

Table 1. Experimental design for avian sampling on the Big Brown Mine, Freestone County, Texas, 2003–2004. Number of points and size of survey area in ha given for each point category.

| Category | Vegetation type | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pasture | | Bottomland forest | | Wetland | | Upland forest | | Total | |
| Age (years) | Number of points | Number of ha | Number of points | Number of ha | Number of points | Number of ha | Number of points | Number of ha | Number of points | Number of ha |
| Non-mined | 22 | 279.62 | 26 | 331.46 | 3 | 38.13 | 24 | 304.04 | 75 | 952.25 |
| 0-5 | 27 | 343.17 | 7 | 88.97 | 12 | 152.52 | 19 | 241.49 | 65 | 826.15 |
| 10-15 | 17 | 216.07 | 5 | 63.55 | 1 | 12.71 | 8 | 101.68 | 31 | 394.01 |
| 20+ | 44 | 559.24 | 8 | 101.68 | 8 | 101.68 | 9 | 114.39 | 69 | 876.99 |
| Total | 110 | 1,398.10 | 46 | 585.66 | 24 | 305.04 | 60 | 761.60 | | |

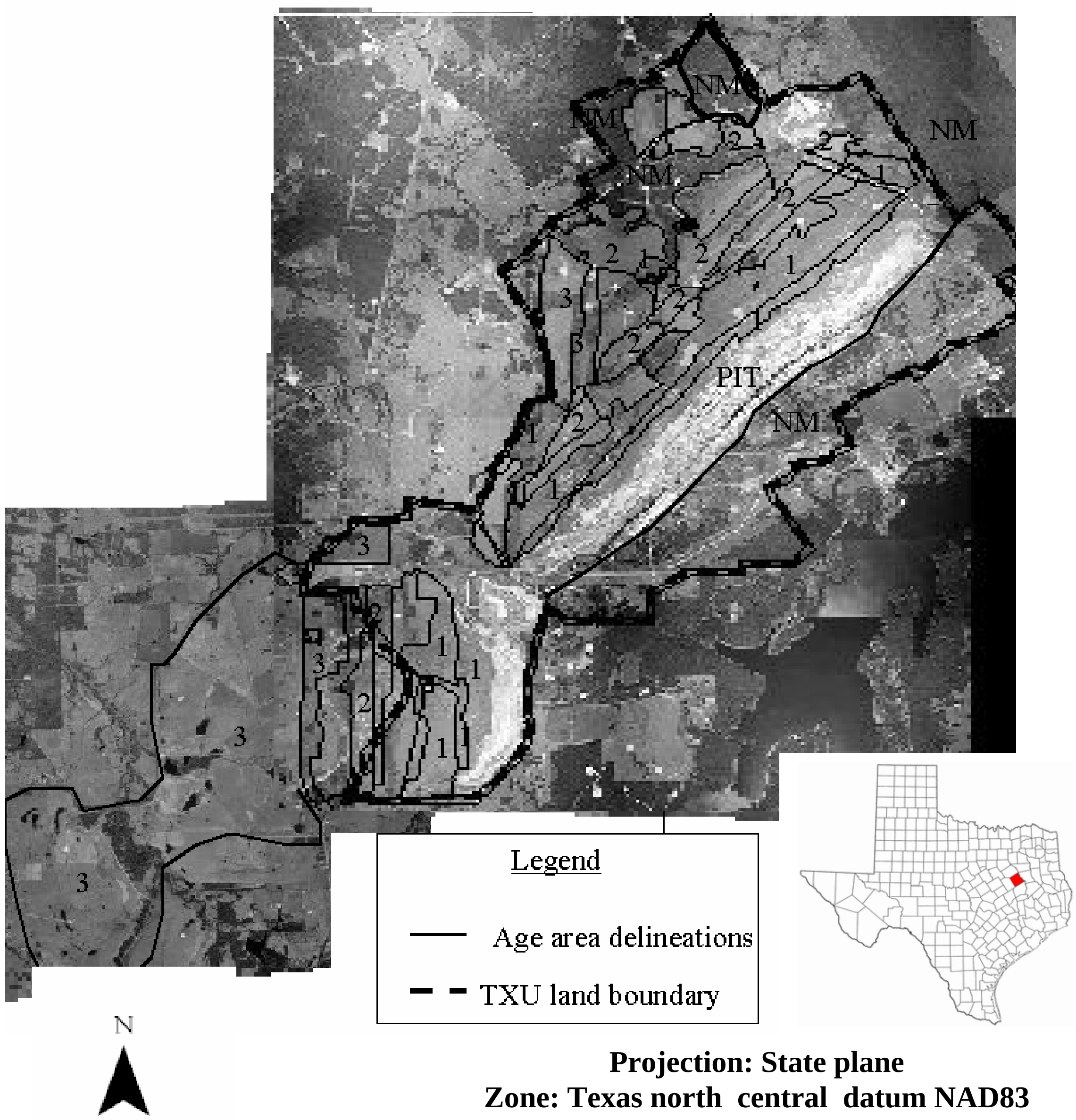
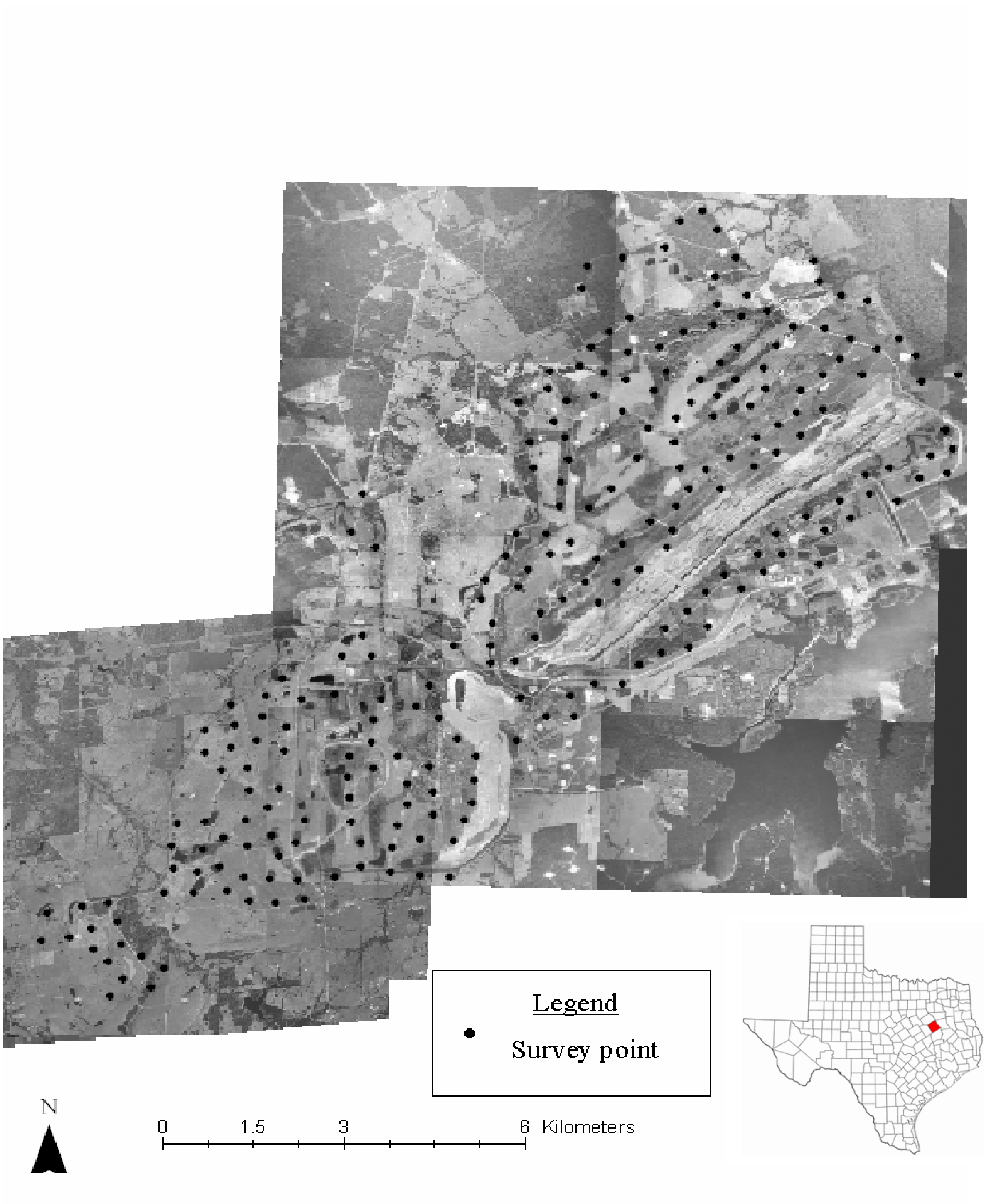



Fig. 2. Age class delineations non-mined and reclaimed areas on Big Brown Mine, Freestone County, Texas. 1 = 0–5 years reclaimed, 2 = 10–15 years reclaimed, 3 = 20+ years reclaimed, NM = non-mined.




**Projection: State plane**
**Zone: Texas north central** datum NAD83

Fig. 3. Survey point locations on Big Brown Mine, Freestone County, Texas.

## Avian Sampling

I sampled birds at each point using a fixed-radius point-count method (Hutto 1986). The sampling radius around each point was 201 m. Routes of 8 to 10 points were made prior to the start of sampling and for practicality and efficiency. A route was selected at random each day for sampling. General weather and point conditions (temperature, cloud cover, wind velocity and direction, and human disturbance) were recorded prior to the start of sampling each point. I conducted sampling 2–3 times per week. Sampling started at sunrise for a 10-min-sampling period at each point, and all birds heard and seen were counted. Sampling continued for approximately 3 hours each morning. Birds were identified to species using the National Geographic Birds of North America field guide (Dickinson 1999). Birds also were sexed (if distinguishable), and method of detection (song, call, seen), breeding evidence, and habitat also was recorded. The distance of a bird from the point was recorded using a range finder. Only birds within the 201 m radius were counted. Direction of an identified bird with respect to the point also was recorded in the second season (Lancia et al. 1996). Sampling began on 15 March 2003 and ran through 30 June 2004. Points were sampled once during the breeding season (15 March–30 June) in 2003 and 2004.

## Vegetation Sampling

*Local analysis.*— I sampled vegetation at each point from 1 March–15 August 2003 and 2004. A 20 x 50-cm quadrat was thrown randomly in the four cardinal directions at each point. Percent forbs, bunchgrass, other grasses, woody species, sedge, litter, and bare ground were estimated in each quadrat (Cantle 1978). A Robel range pole (Robel et al. 1970) also was used in each cardinal direction at each point to record visual obstruction. Herbaceous vegetation measurements were taken both years. Woody vegetation measurements were taken only in the second year due to their fairly stable nature. Species, height, diameter at breast height (DBH), and tree-canopy cover were recorded using an 8-m-circular plot around each point (Stoleson and Finch 2001).

*Landscape analysis*.—GPS locations taken at each point in the field during avian surveys were overlaid onto an aerial photo of the mine area using a geographic information system (GIS; ArcGIS 8.3). Using the visual data from the aerial photo for vegetation type and the predetermined reclaimed-age areas from TXU, I digitized different vegetation types on the map (Fig. 4). The vegetation types included non-mined forest, non-mined pasture, reclaimed forest, reclaimed pasture, pond, and oil well pad. From this point, I created a 201-m radius-buffer zone around each point which represented the avian count area of each point. This area was defined as the landscape for each point. The percent that each vegetation type represented within this zone for each point was then calculated. The number of different vegetation types and the number of vegetation patches surrounding each point also was calculated. In addition, I calculated the distance to the nearest pond for each point.

**Data Analyses**

*Density*.—Overall density for the entire mine area was found for both survey years and the two years combined by counting the number of individuals observed divided by the total amount of hectares observed on the mine. The same process was repeated for overall density on just the non-mined lands and just the reclaimed lands.

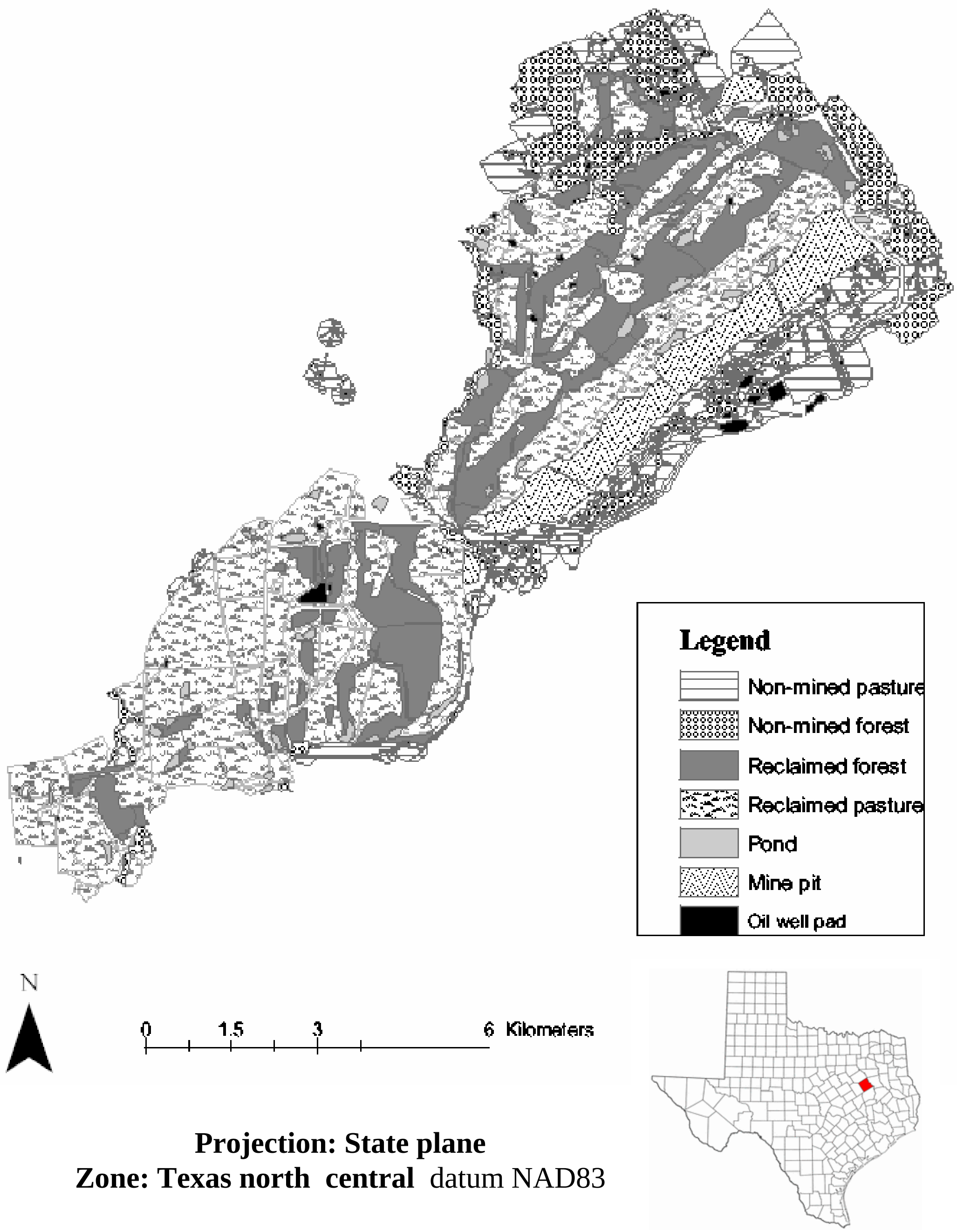



Fig. 4. Location of vegetation categories used in landscape vegetation analysis on Big Brown Mine, Freestone County, Texas.

Mean/point overall density was found over the entire mine for each survey year and both years combined by averaging all of the point densities. Point density was found for each point by counting the number of individuals observed at the point and dividing by the survey area of the point (12.71 ha). This process was repeated using mean/point density from only the non-mined area points and the reclaimed area points.

*Diversity.*—Overall diversity for the entire mine was found using Shannon diversity index:

$$H = -\sum_{i=1}^{s} p_i \ln p_i$$

where *p* equals the total number of species and the proportion of species *i* relative to the total number of species ($p_i$) is calculated (Krebs 1999). The Shannon index was calculated using the number of species and number of individuals in each species over the entire mine area for 2003, 2004, and both years combined. The process was then repeated using number of species and number of individuals in each species on non-mined lands only and reclaimed lands only.

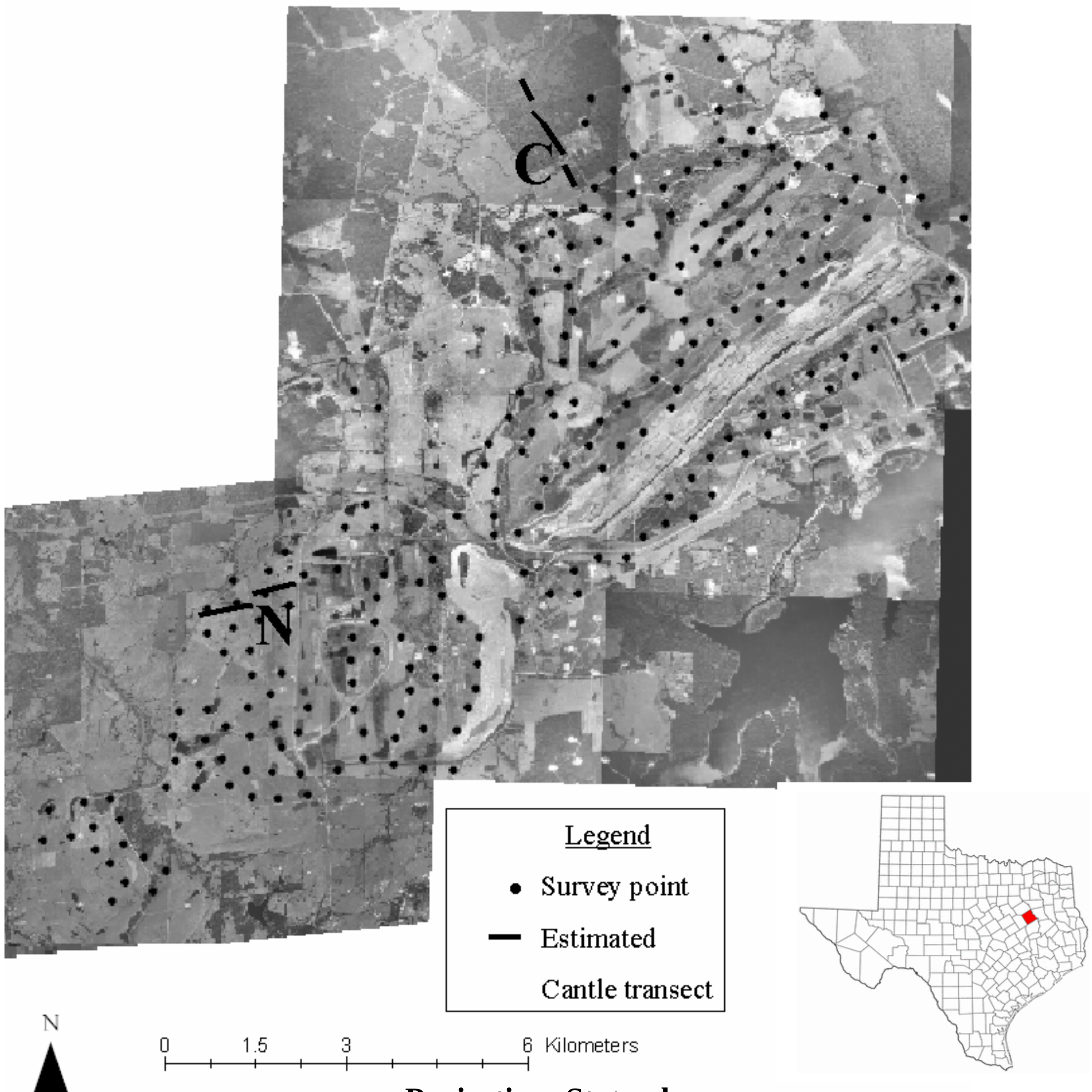
Overall mean/point diversity was calculated by averaging the diversity found for each point. Diversity for each point was found using Shannon index and was calculated using the number of species and number of individuals in each species at each point. Overall mean/point density was found for the overall mine area for each year and both years combined. The process was then repeated using diversity from only the non-mined points and the reclaimed points.

*Richness*.—Overall richness for the mine area was found by counting the number of species seen on the entire area for each year and both years combined. The number of species on the non-mined lands and reclaimed lands were also counted for each year and both years combined.

Overall mean/point richness was found by averaging the richness for each point on the entire mine area for each year and both years combined. Richness for each point was found by counting the number of species seen at the point. This process was repeated using mean/point richness for the non-mined lands and reclaimed lands only.

*Age class and vegetation type comparisons*.—The first step in analyzing data was to count the number of individual birds and species surveyed over the two breeding seasons. The species were placed in a list of descending order in accordance with the number of individuals counted for each species. Mean/point density was found for each point for each breeding season using the count of individuals per point divided by the count area per point (12.71 ha). Mean/point diversity was found using Shannon index. Mean/point species richness also was found for each point by counting the number of species at each point. ANOVAs (Ott and Longnecker 2001) were used to compare mean density, diversity, and richness among the two breeding seasons. Mean/point density diversity, and richness were compared among age classes within each vegetation type first and age-class categories were pooled if no significant ($P > 0.05$) differences were found. Mean/point density, diversity, and richness were then compared among vegetation types using the pooled age-class categories.

*Guild comparison*.—Species were placed in nesting guilds (Appendix A) using information on each birds nesting habitat and habits from Thayer Birding Software (1998) and the guilds used Cantle's (1978) research. Mean/point density for each species




**Projection: State plane**
**Zone: Texas north central** datum NAD83

Fig. 5. Location of Cantle's (1978) transects and 2003-2004 survey points on Big Brown Mine, Freestone County, Texas. N = newly reclaimed transect; C = control transect

in the guild was found for each point by counting the number of individuals in the guild seen at the point and dividing by the point count area (12.71 ha). An ANOVA was then used to compare guild densities between age classes and vegetation types using the same process as above.

*Comparison with previous study*.—My reclaimed age class data of 0–5 years were compared with Cantle's (1978) reclamation data because Cantle's thesis did not contain older reclamation areas. Points were not separated into vegetation classes for this comparison because Cantle did not make a vegetation distinction. Mean density, diversity, and richness per point found in my data were compared with Cantle's results using an ANOVA. My overall density, diversity, and richness results were not comparable to Cantle's results as his data was given as mean per transect and not as overall reclaimed or non-mined. I compared species seen at my points that were on or near Cantle's original survey transects. I was able to compare to Cantle's control and newly reclaimed transects, but was unfortunately unable to gain access to the land which contained his gradient reclaim transect (Fig. 5).

*Local vegetation correlations*.—I used a Pearson's correlation (Ott and Longnecker 2001) to determine if mean densities per point of the 10 most numerous species over the entire area and in the non-mined and reclaimed areas were correlated with local vegetation data collected at each point for both breeding seasons. I also used a Pearson's correlation to determine if mean densities of species of conservation concern were correlated to vegetation data for both breeding seasons. I used a Pearson's correlation to determine if woody vegetation was correlated with mean bird species densities for the second breeding season only because woody vegetation was only measured during this period.

*Landscape vegetation correlations.*—I performed Pearson's correlations between mean bird species density, diversity, and richness, as well as guild density, of each point and the percent of each vegetation type, number of vegetation types, number of vegetation patches, and distance to the nearest pond.

# RESULTS

## Density

A total of 6,409 individual birds on 3,050.40 ha of land was observed during both breeding seasons with 3,374 birds observed in 2003 and 3,071 birds observed in 2004. The overall density of the entire mine area for both seasons combined was 1.05 individuals/ha, with an overall density of 1.11 individuals/ha in 2003 and 1.01 individuals/ha in 2004. The mean/point density (average of the density of each point) of the entire mine area for both seasons combined was 1.07 ± 0.03 individuals/ha ($n$ = 480), with a mean/point density of 1.12 ± 0.05 individuals/ha ($n$ = 240) in 2003 and a mean/point density of 1.03 ± 0.04 individuals/ha ($n$ = 240) in 2004. Three national species of conservation concern (Partners in Flight 2005), one state species of conservation concern, one state listed threatened species, and one federally and state listed endangered species (Texas Parks and Wildlife Department 2003) were observed during the two breeding seasons. These were the Bell's Vireo, Painted bunting, Dickcissel, American Redstart, Wood Stork, and Interior Least Tern, respectively. However, the Interior Least Tern was only observed while traveling on the area and was not observed at any of the survey points.

A total of 2,079 individuals on 953.25 ha was observed on the non-mined areas over both seasons, with 1,017 individuals in 2003 and 1,062 individuals in 2004. The overall density on the non-mined area for both seasons combined was 1.09 individuals/ha, with an overall density of 1.07 individuals/ha in 2003 and 1.11 individuals/ha in 2004. The mean/point bird density on the non-mined areas was 1.11 ±

0.05 individuals/ha (*n* = 150) over both breeding seasons, with a mean/point density of 1.07 ± 0.06 individuals/ha (*n* = 75) in 2003 and 1.16 ± 0.09 individuals/ha (*n* = 75) in 2004.

The reclaimed areas had 4,329 individuals observed on 2,097.15 ha over both seasons, with 2,357 individuals in 2003 and 2,009 individuals in 2004. The overall density of the reclaimed area for both seasons combined was 1.03 individuals/ha, with an overall density of 1.12 individuals/ha in 2003 and 0.96 individuals/ha in 2004. The mean/point bird density on the reclaimed areas was 1.06 ± 0.04 individuals/ha (*n* = 330) over both seasons, with a mean/point density of 1.14 ± 0.07 individuals/ha (*n* = 165) in 2003 and 0.97 ± 0.04 individuals/ha (*n* = 165) in 2004.

The mean/point density of the reclaimed areas versus the non-mined areas was not significantly different in 2003 ($F = 0.33$, $P = 0.56$, $df = 239$) or over both breeding seasons combined ($F = 0.65$, $P = 0.42$, $df = 479$). However in 2004, mean/point density of the non-mined areas was greater ($F = 4.69$, $P = 0.03$, $df = 239$) than that of the reclaimed areas.

The 10 most numerous species in the non-mined, reclaimed, and the overall area are listed in Table 2. Eight out of 10 of the most numerous species on the overall area were observed more than half the time in reclaimed areas (Table 3).

**Diversity**

The overall Shannon diversity index (*H*) for the mine area as a whole was 4.91 over both seasons combined, with a diversity of 4.84 in 2003 and 4.76 in 2004. An overall mean/point Shannon diversity index of 2.34 ± 0.03 (*n* = 480) was found for overall diversity of the mine area over both seasons, with a mean/point index of 2.42 ± 0.04 (*n* = 240) in 2003 and 2.27 ± 0.04 (*n* = 240) in 2004.

The non-mined area had an overall Shannon diversity of 4.72 over both seasons combined, with a diversity of 4.54 in 2003 and 4.61 in 2004. The non-mined area had a mean/point Shannon index of 2.70 ± 0.05 (*n* = 150) over both seasons and 2.84 ± 0.05 (*n* = 75) in 2003 and 2.57 ± 0.08 (*n* = 75) in 2004.

The reclaimed area had an overall Shannon diversity of 4.51 over both seasons, with a diversity of 4.44 in 2003 and 4.34 in 2004. The reclaimed area had mean/point diversity index of 2.18 ± 0.03 (*n* = 330) over both seasons and 2.23 ± 0.05 (*n* = 165) in 2003 and 2.13 ± 0.05 (*n* = 165) in 2004.

The mean/point diversity was significantly greater in the non-mined areas than the reclaimed areas for 2003 ($F = 50.51$, $P < 0.001$, $df = 239$), 2004 ($F = 24.28$, $P < 0.001$, $df = 239$), and over both seasons combined ($F = 70.84$, $P < 0.001$, $df = 479$).

**Richness**

An overall richness of 102 different bird species was recorded over the entire mine area during both survey years (Appendix A) out of 142 abundant, common, and uncommon species on the checklist of the area (Frenz 1998). An overall richness of 82 species was observed in 2003 and 87 in 2004. The mean richness of the overall mine area was 6.76 ± 0.11 (*n* = 480) for both seasons combined, 6.98 ± 0.16 (*n* = 240) in 2003, and 6.48 ± 0.16 in 2004. Fourteen species were seen in 2003 that were not seen in 2004. These species were: Barn Owl, Baltimore Oriole, Common Nighthawk, Eurasian Collared-Dove, Eurasian Starling, Gray Catbird, Greater Yellowlegs, Lark Sparrow,

Table 2. Ten most numerous bird species on the overall mine area, non-mined area, and on the reclaimed area at Big Brown Mine, Freestone County, Texas, 2003–2004. Numbers in parentheses after the species name represent number of individuals counted over 2003 and 2004 combined.

| Overall area | Non-mined area | Reclaimed area |
| --- | --- | --- |
| 1. [a]Dickcissel (1,017) | 1. Northern Cardinal (314) | 1. [a]Dickcissel (942) |
| 2. Red-winged Blackbird (603) | 2. Carolina Wren (147) | 2. Red-winged Blackbird (487) |
| 3. Northern Cardinal (512) | 3. Brown-headed Cowbird (146) | 3. Eastern Meadowlark (312) |
| 4. Eastern Meadowlark (323) | 4. Tufted Titmouse (132) | 4. Cliff Swallow (226) |
| 5. Mourning Dove (269) | 5. White-eyed Vireo (121) | 5. Grasshopper Sparrow (221) |
| 6. Brown-headed Cowbird (251) | 6. Red-winged Blackbird (116) | 6. Northern Cardinal (198) |
| 7. Cliff Swallow (235) | 7. Cedar Waxwing (100) | 7. Mourning Dove (197) |
| 8. Scissor-tailed Flycatcher (231) | 8. Blue Jay (96) | 8. Scissor-tailed Flycatcher (191) |
| 9. Grasshopper Sparrow (229) | 9. Carolina Chickadee (95) | 9. European Starling (150) |
| 10. Carolina Wren (202) | 10. [a]Dickcissel (75) | 10. [a]Painted Bunting (119) |

[a]Indicates species of concern

Table 3. Number of birds observed of the overall mine area top 10 species and percent of all individuals counted occurring in the reclaimed areas at Big Brown Mine, Freestone County, Texas, 2003–2004.

| Overall top ten species | 2003 | | | 2004 | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | [b]$n_o$ | $n_r$ | % | $n_o$ | $n_r$ | % | $n_o$ | $n_r$ | % |
| 1. [a]Dickcissel | 487 | 477 | 98 | 564 | 501 | 89 | 1017 | 942 | 93 |
| 2. Red-winged Blackbird | 274 | 250 | 91 | 329 | 237 | 72 | 603 | 487 | 81 |
| 3. Northern Cardinal | 284 | 108 | 38 | 228 | 90 | 39 | 512 | 198 | 39 |
| 4. Eastern Meadowlark | 185 | 177 | 96 | 138 | 135 | 98 | 323 | 312 | 97 |
| 5. Mourning Dove | 166 | 123 | 74 | 103 | 74 | 72 | 269 | 197 | 73 |
| 6. Brown-headed Cowbird | 149 | 50 | 34 | 102 | 55 | 54 | 251 | 105 | 42 |
| 7. Cliff Swallow | 155 | 145 | 94 | 80 | 78 | 98 | 235 | 226 | 96 |
| 8. Scissor-tailed Flycatcher | 122 | 108 | 89 | 109 | 83 | 76 | 231 | 191 | 83 |
| 9. Grasshopper Sparrow | 115 | 109 | 95 | 114 | 112 | 98 | 229 | 221 | 97 |
| 10. Carolina Wren | 113 | 29 | 26 | 89 | 26 | 29 | 202 | 55 | 27 |

[a] Indicates species of concern [b]$n_o$ = number of individuals on entire mine, $n_r$ = number of individuals in reclaimed areas, % = percent of total number of individuals observed which occurred in reclaimed areas

Marsh Wren, Northern Flicker, Orange-Crowned Warbler, Pine Warbler, Song Sparrow, and Upland Sandpiper. Nineteen species were seen in 2004 that were not seen in 2003. These species were: Acadian Flycatcher, American Redstart, Cedar Waxwing, Common Yellowthroat, Crested Caracara, Double-Crested Cormorant, House Sparrow, Inca Dove, Ladder-backed Woodpecker, Loggerhead Shrike, Mourning Warbler, Northern Harrier, Sharp-Shinned Hawk, Swainson’s Hawk, Vesper Sparrow, White-Throated Sparrow, Wilson’s Warbler, Wood Stork, and Yellow Warbler.

In the non-mined area, the overall richness was 64 species observed over both seasons, with 58 species in 2003 and 54 species in 2004. The mean/point richness for the non-mined areas was 8.13 ± 0.19 ($n$ = 150) over both seasons combined, 6.48 ± 0.16 ($n$ = 240) in 2003, and 7.81 ± 0.28 ($n$ = 75) in 2004.

The reclaimed area had a richness of 86 species observed over both seasons, with 64 species in 2003 and 76 species in 2004. The mean/point richness of the reclaimed areas was 6.10 ± 0.13 ($n$ = 330) over both seasons, 6.32 ± 0.18 ($n$ = 165) in 2003, and 5.88 ± 0.18 ($n$ = 165) in 2004.

Mean/point richness was significantly greater in the non-mined versus the reclaimed areas over both seasons combined ($F$ = 80.28, $P$ < 0.001, $df$ = 479), 2003 ($F$ = 46.82, $P$ < 0.001, $df$ = 239), and 2004 ($F$ = 34.87, $P$ < 0.001, $df$ = 239).

**Age Class and Vegetation Type Comparisons**

*Density.*— Tables 4 and 5 display mean/point point density by different age classes and vegetation types, respectively, for 2003 and 2004. As there were several comparisons made between age and vegetation types, I will only highlight the significant differences found.

In 2003, only the upland vegetation types had significant ($P$ < 0.05) differences between mean/point density among age classes (Table 4; Fig. 6). The mean/point density of non-mined upland points differed from the 0–5 years reclaimed category (hereafter referred to as age-class category 1), the 10–15 year age class (hereafter referred to as age-class category 2), and the over 20 years age class (hereafter referred to as age class category 3). The mean/point density of upland 1 was greater than that of non-mined upland (*F* = 4.97, *P* = 0.03, *df* = 43), the upland 2 age class (*F* = 5.44, *P* = 0.03, *df* = 26), and the upland 3 age class (*F* = 5.34, *P* = 0.03, *df* = 27). The mean/point density of the non-mined upland age class was greater than that of upland 2 (*F* = 5.78, *P* = 0.02, *df* = 32), as well as upland 3 (*F* = 4.80, *P* = 0.04, *df* = 33).

After pooling all age classes except the upland, only one significant difference was found between mean/point density among vegetation types in 2003 (Table 5; Fig. 7). The mean/point density of the wetland vegetation type was greater (*F* = 4.41, *P* = 0.04, *df* = 135) than that of the pasture vegetation type. In 2004, no significant differences were found between mean/point density of age classes or vegetation types (Tables 4 and 5).

*Diversity.*— Tables 6 and 7 display the mean/point diversity of the different age and vegetation types after age class pooling, respectively, in 2003 and 2004. In 2003, the non-mined bottomland age class had a significantly greater mean/point diversity than that of bottomland 1 (*F* = 6.52, *P* = 0.02, *df* = 31) and 3 (*F* = 10.13, *P* < 0.001, *df* =31) age classes. The mean/point diversity of the non-mined pasture age class also was significantly greater than that of pasture 1 (*F* = 15.76, *P* < 0.001, *df* = 47), pasture 2 (*F* = 7, *P* = 0.01, *df* = 39), and pasture 3 (*F* = 5.30, *P* = 0.03, *df* = 65). The mean/point diversity of the non-mined upland age class was significantly greater than that of upland 1 (*F* = 38.81, *P* < 0.001, *df* = 43) and upland 2 (*F* = 9.06, *P* < 0.001, *df* = 32). No differences were found between mean/point diversity among the wetland age classes (Table 6; Fig. 8).

Table 4. Mean bird density (individuals/ha) of non-mined and reclaimed areas by age class at Big Brown Mine, Freestone County, Texas for 2003 and 2004. Groups that share the same capital letter(s) among the same vegetation groups are not statistically ($P < 0.05$) different.

| 2003 | | | 2004 | | |
|---|---|---|---|---|---|
| Age class[a] | Density (individuals/ha) | | Age class[a] | Density (individuals/ha) | |
| | $\bar{x}$ ± SE | $n$ | | $\bar{x}$ ± SE | $n$ |
| NMBL | 1.20 ± 0.17$^{A}$ | 26 | NMBL | 1.15 ± 0.11$^{A}$ | 26 |
| BL1 | 1.20 ± 0.15$^{A}$ | 7 | BL1 | 1.10 ± 0.14$^{A}$ | 7 |
| BL2 | 0.99 ± 0.06$^{A}$ | 5 | BL2 | 0.98 ± 0.17$^{A}$ | 5 |
| BL3 | 0.78 ± 0.17$^{A}$ | 8 | BL3 | 0.94 ± 0.17$^{A}$ | 8 |
| | | | | | |
| NMUL | 1.04 ± 0.05$^{A}$ | 24 | NMUL | 1.27 ± 0.21A | 24 |
| UL1 | 1.39 ± 0.16$^{B}$ | 19 | UL1 | 1.04 ± 0.09$^{A}$ | 19 |
| UL2 | 0.77 ± 0.12$^{C}$ | 8 | UL2 | 0.77 ± 0.16$^{A}$ | 8 |
| UL3 | 0.81 ± 0.09$^{C}$ | 9 | UL3 | 1.00 ± 0.14$^{A}$ | 9 |
| | | | | | |
| NMP | 0.98 ± 0.07$^{A}$ | 22 | NMP | 1.08 ± 0.11$^{A}$ | 22 |
| P1 | 1.13 ± 0.15$^{A}$ | 27 | P1 | 0.83 ± 0.08$^{A}$ | 27 |
| P2 | 1.18 ± 0.15$^{A}$ | 17 | P2 | 0.90 ± 0.15$^{A}$ | 17 |
| P3 | 1.00 ± 0.05$^{A}$ | 44 | P3 | 1.09 ± 0.11$^{A}$ | 44 |
| | | | | | |
| NMWL | 0.92 ± 0.07$^{A}$ | 3 | NMWL | 0.87 ± 0.24$^{A}$ | 3 |
| WL1 | 1.36 ± 0.20$^{A}$ | 12 | WL1 | 0.80 ± 0.11$^{A}$ | 12 |
| WL2 | 1.34 ± 0.00$^{A}$ | 1 | WL2 | 1.57 ± 0.00$^{A}$ | 1 |
| WL3 | 1.91 ± 0.84$^{A}$ | 8 | WL3 | 1.04 ± 0.09$^{A}$ | 8 |

[a]BL = bottomland forest, UL = upland forest, P = pasture, WL = wetland, NM = non-mined, 1 = 0–5 years reclaimed, 2 = 10–15 years reclaimed, 3 = 20+ years reclaimed

Table 5. Mean bird density (individuals/ha) of non-mined and reclaimed areas by vegetation type at Big Brown Mine, Freestone County, Texas for 2003 and 2004. Groups that share the same capital letter(s) among the same vegetation groups are not statistically ($P$ < 0.05) different.

| 2003 | | | 2004 | | |
|---|---|---|---|---|---|
| Vegetation type[a] | Density (individuals/ha) | | Vegetation type[a] | Density (individuals/ha) | |
| | $\bar{x}$ ± SE | *n* | | $\bar{x}$ ± SE | *n* |
| BL pooled | 1.11 ± 0.10 [AB] | 46 | BL pooled | 1.09 ± 0.07 [A] | 46 |
| NMUL | 1.04 ± 0.05 [AB] | 24 | UL pooled | 1.09 ± 1.00 [A] | 60 |
| UL23 pooled | 0.79 ± 0.07 [AB] | 17 | | | |
| P pooled | 1.06 ± 0.07 [A] | 110 | P pooled | 1.00 ± 0.06 [A] | 110 |
| WL pooled | 1.50 ± 0.30 [B] | 24 | WL pooled | 0.93 ± 0.07 [A] | 24 |

[a]BL = bottomland forest, UL = upland forest, P = pasture, WL = wetland, NM = non-mined, 1 = 0–5 years reclaimed, 2 = 10–15 years reclaimed, 3 = 20+ years reclaimed

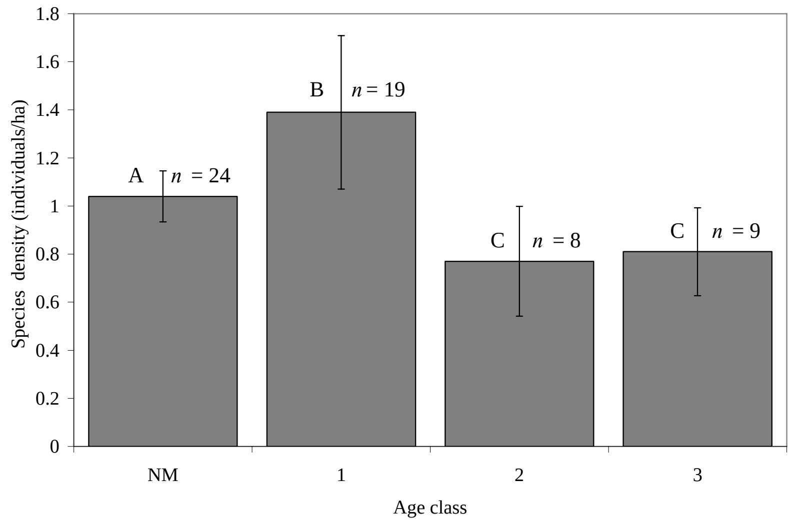



Fig. 6. Differences (error bars represent 95% confidence interval) in mean bird density (individuals/ha) between age classes (NM = non-mined, 1 = reclaimed 0–5 years, 2 = reclaimed 10–15 years, 3 = reclaimed 20+ years ) on non-mined and reclaimed areas in the upland vegetation class at Big Brown Mine, Freestone County, Texas for 2003. Bars that share the same capital letter(s) among the same vegetation groups are not statistically (*P* < 0.05)

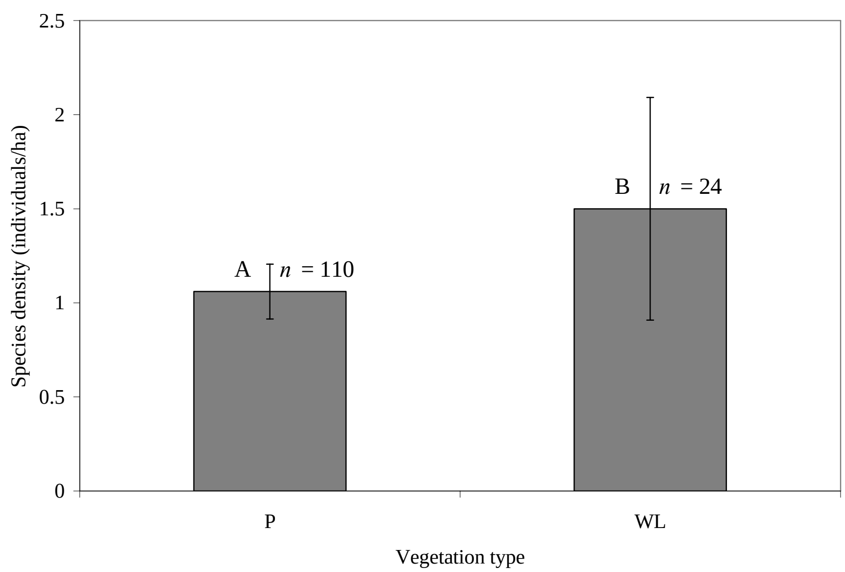



Fig. 7. Differences (error bars represent a 95% confidence interval) in mean bird density (individuals/ha) among vegetation types (P = pasture, WL = wetland) on non-mined and reclaimed areas at Big Brown Mine, Freestone County, Texas for 2003. Statistically significant differences are indicated by the capital letter(s) above the bars. Bars that share the same letter(s) are not statistically different

Table 6. Mean bird diversity (*H*) of non-mined and reclaimed areas by age class at Big Brown Mine, Freestone County, Texas for 2003 and 2004. Groups that share the same capital letter(s) among the same vegetation groups are not statistically ($P < 0.05$) different.

| 2003 | | | 2004 | | |
|---|---|---|---|---|---|
| Age class[a] | Diversity (*H*) | | Age class[a] | Diversity (*H*) | |
| | $\bar{x}$ ± SE | *n* | | $\bar{x}$ ± SE | *n* |
| NMBL | 2.92 ± 0.09 [A] | 26 | NMBL | 2.71 ± 0.14 [A] | 26 |
| BL1 | 2.35 ± 0.28 [B] | 7 | BL1 | 2.56 ± 0.36 [A] | 7 |
| BL2 | 2.49 ± 0.35 [AB] | 5 | BL2 | 2.42 ± 0.30 [A] | 5 |
| BL3 | 2.26 ± 0.23 [B] | 8 | BL3 | 2.72 ± 0.18 [A] | 8 |
| NMUL | 2.93 ± 0.10 [A] | 24 | NMUL | 2.62 ± 0.11 [A] | 24 |
| UL1 | 1.99 ± 0.11 [B] | 19 | UL1 | 2.04 ± 0.14 [B] | 19 |
| UL2 | 2.23 ± 0.28 [B] | 8 | UL2 | 2.42 ± 0.18 [ABC] | 8 |
| UL3 | 2.47 ± 0.33 [AB] | 9 | UL3 | 2.57 ±0.19 [AC] | 9 |
| NMP | 2.65 ± 0.10 [A] | 22 | NMP | 2.47 ± 0.13 [A] | 22 |
| P1 | 2.06 ± 0.10 [B] | 27 | P1 | 1.77 ± 0.10 [B] | 27 |
| P2 | 2.17 ± 0.16 [B] | 17 | P2 | 1.86 ± 0.16 [BC] | 17 |
| P3 | 2.26 ± 0.11 [B] | 44 | P3 | 2.12 ± 0.07 [C] | 44 |
| NMWL | 2.77 ± 0.24 [A] | 3 | NMWL | 1.62 ± 0.43 [A] | 3 |
| WL1 | 2.41 ± 0.11 [A] | 12 | WL1 | 1.89 ± 0.15 [A] | 12 |
| WL2 | 1.76 ± 0.00 [A] | 1 | WL2 | 1.08 ± 0.00 [A] | 1 |
| WL3 | 2.51 ± 0.27 [A] | 8 | WL3 | 2.74 ± 0.14 [B] | 8 |

[a]BL = bottomland forest, UL = upland forest, P = pasture, WL = wetland, NM = non-mined, 1 = 0–5 years reclaimed, 2 = 10–15 years reclaimed, 3 = 20+ years reclaimed

Table 7. Mean bird diversity (*H*) of non-mined and reclaimed areas by vegetation type at Big Brown Mine, Freestone County, Texas for 2003 and 2004. Groups that share the same capital letter(s) among the same vegetation groups are not statistically ($P < 0.05$) different.

| 2003 | | | 2004 | | |
|---|---|---|---|---|---|
| Vegetation type[a] | Diversity (*H*) $\bar{x}$ ± SE | *n* | Vegetation type[a] | Diversity (*H*) $\bar{x}$ ± SE | *n* |
| NMBL | 2.92 ± 0.09 $^{AD}$ | 26 | BL pooled | 2.66 ± 0.11 $^{AC}$ | 46 |
| BL123 pooled | 2.34 ± 0.16 $^{BCDE}$ | 20 | | | |
| NMUL | 2.93 ± 0.10 $^{AD}$ | 24 | NMUL | 2.62 ± 0.11 $^{AC}$ | 24 |
| | | | UL1 | 2.04 ± 0.14 $^{BDEF}$ | 19 |
| UL123 pooled | 2.16 ± 0.12 $^{CE}$ | 17 | UL2 | 2.42 ± 0.18 $^{CDFH}$ | 8 |
| | | | UL3 | 2.57 ±0.19 $^{CH}$ | 9 |
| NMP | 2.65 ± 0.10 $^{ADE}$ | 22 | NMP | 2.47 ± 0.13 $^{AC}$ | 22 |
| | | | P1 | 1.77 ± 0.10 $^{E}$ | 27 |
| P123 pooled | 2.21 ± 0.07 $^{BCE}$ | 88 | P2 | 1.86 ± 0.16 $^{BDEF}$ | 17 |
| | | | P3 | 2.12 ± 0.07 $^{DFG}$ | 44 |
| | | | NMWL | 1.62 ± 0.43 $^{BE}$ | 3 |
| WL pooled | 2.46 ± 0.12 $^{BCE}$ | 24 | WL1 | 1.89 ± 0.15 $^{BEG}$ | 12 |
| | | | WL2 | 1.08 ± 0.00 $^{BE}$ | 1 |
| | | | WL3 | 2.74 ± 0.14 $^{AH}$ | 8 |

[a]BL = bottomland forest, UL = upland forest, P = pasture, WL = wetland, NM = non-mined, 1 = 0–5 years reclaimed, 2 = 10–15 years reclaimed, 3 = 20+ years reclaimed

A few significant differences were observed when mean/point bird species diversity was compared among vegetation types in 2003 (Table 7). The mean/point diversity of the non-mined bottomland points was greater than mean/point diversity of the pooled reclaimed (age classes 1, 2, and 3) pasture points ($F = 25.62$, $P < 0.001$, $df = 108$), the pooled reclaimed upland points ($F = 224$, $P < 0.001$, $df = 60$), and all of the wetland points ($F = 9.89$, $P < 0.001$, $df = 49$). The mean/point diversity of the non-mined upland points was greater than pooled reclaimed bottomland points ($F = 10.44$, $P < 0.001$, $df = 42$), the pooled reclaimed pasture points ($F = 25.07$, $P < 0.001$, $df = 108$), and all of the wetland points ($F = 9.12$, $P < 0.001$, $df = 49$). Finally, the mean/point diversity of the non-mined pasture points was greater ($F = 8.23$, $P < 0.001$, $df = 57$) than that of pooled reclaimed upland points (Fig. 10).

In 2004, no significant differences were found between mean/point diversity of age classes among the bottomland points (Table 6). However, the non-mined pasture points had a significantly greater mean/point bird diversity than all of the reclaimed points, including pasture 1 ($F = 18.64$, $P < 0.001$, $df = 47$), pasture 2, ($F = 9.19$, $P <$ 0001, $df = 39$) and pasture 3 ($F = 6.62$, $P = 0.01$, $df = 65$). Mean/point bird diversity of pasture 1 points also was greater than pasture 3 ($F = 8.02$, $P < 0.001$, $df = 69$). The non-mined upland age class had a greater ($F = 10.85$, $P < 0.001$, $df = 43$) mean/point bird diversity than the upland 1 age class and the upland 1 age class had a greater ($F = 4.56$, $P = 0.04$, $df = 27$) mean/point diversity than the upland 3 class (Fig. 9). Finally, the wetland 3 age class had a greater mean/point diversity than all of the other wetland age

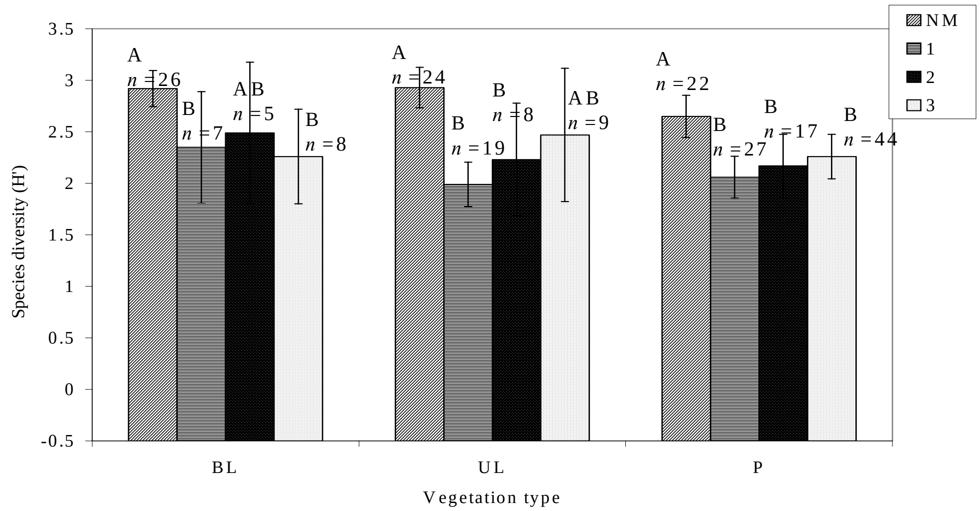



Fig. 8. Differences (error bars represent a 95% confidence interval) in mean bird diversity (*H*) among age classes (NM = non-mined, 1 = reclaimed 0–5 years, 2 = reclaimed 10–15 years, 3 = reclaimed 20+ years, BL = bottomland, UL = upland, P = pasture) on non-mined and reclaimed areas at Big Brown Mine, Freestone County, Texas for 2003. Bars that share the same capital letter(s) among the same vegetation groups are not statistically ($P$ < 0.05) different.

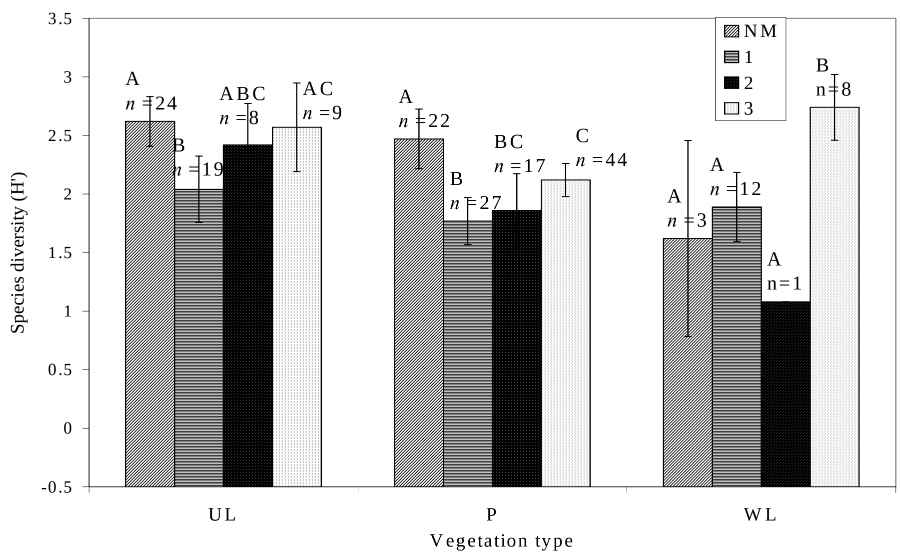



Fig. 9. Differences (error bars represent a 95% confidence interval) in mean bird diversity (*H*) among age classes (NM = non-mined, 1 = reclaimed 0–5 years, 2 = reclaimed 10–15 years, 3 = reclaimed 20+ years, BL = bottomland, UL = upland, P = pasture, WL = wetland) on non-mined and reclaimed areas at Big Brown Mine, Freestone County, Texas for 2004. Statistically significant differences are indicated by the capital letter(s) above the bars. Bars that share the same letter(s) among the same vegetation types are not statistically different.

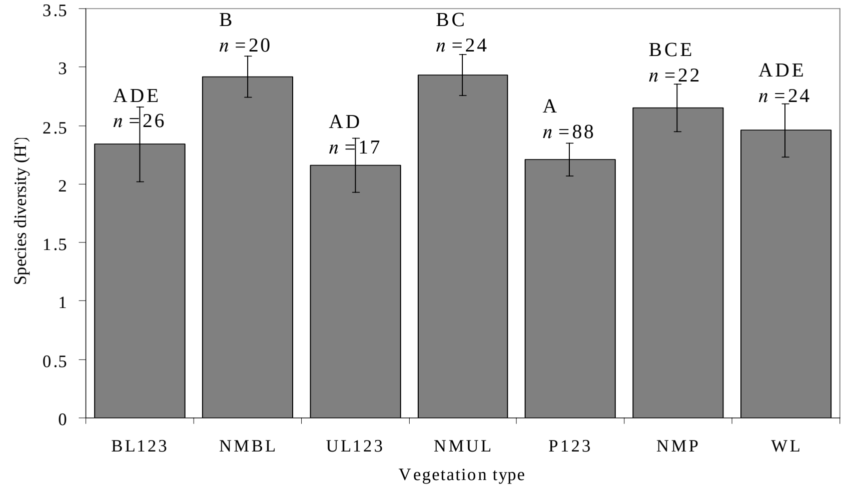



Fig. 10. Differences (error bars represent a 95% confidence interval) in mean bird diversity (*H*) among vegetation types (NM = non-mined, 1 = reclaimed 0–5 years, 2 = reclaimed 10–15 years, 3 = reclaimed 20+ years, BL = bottomland, UL = upland, P = pasture, WL = wetland) on non-mined and reclaimed areas at Big Brown Mine, Freestone County, Texas for 2003. Bars that share the same capital letter(s) among the same vegetation groups are not statistically ($P < 0.05$) different.

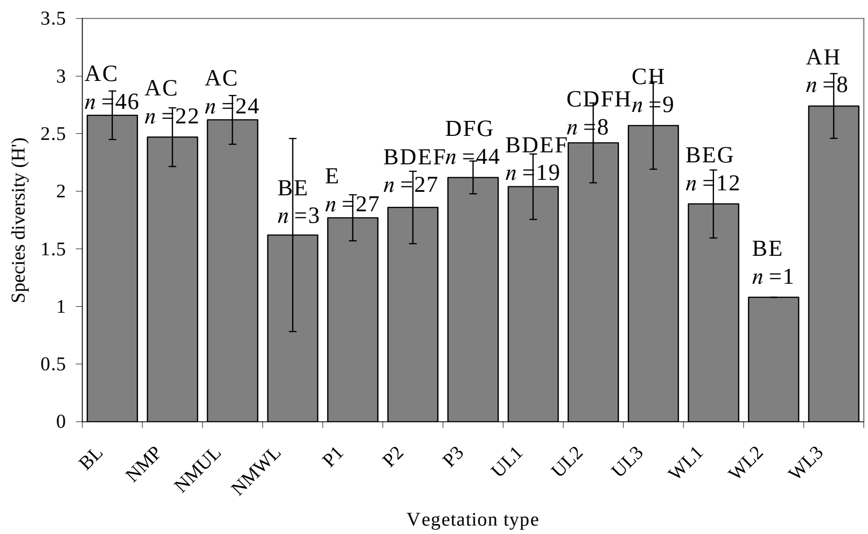



Fig. 11. Differences (error bars represent a 95% confidence interval) in mean bird diversity (*H*) among vegetation types (NM = non-mined, 1 = reclaimed 0–5 years, 2 = reclaimed 10–15 years, 3 = reclaimed 20+ years, BL = bottomland, UL = upland, P = pasture, WL = wetland) on non-mined and reclaimed areas at Big Brown Mine, Freestone County, Texas for 2004.

classes, including non-mined wetland ($F = 10.76$, $P < 0.001$, $df = 11$), wetland 1 ($F = 15.65$, $P < 0.001$, $df = 20$), and wetland 2 ($F = 13.37$, $P < 0.001$, $df = 9$).

Comparison of mean/point bird diversity between vegetation types for 2004 produced several significant differences (Table 7; Fig. 11). The mean/point bird diversity of the pooled bottomland points was greater than mean/point bird diversity all of the reclaimed pasture points (pasture 1 [$F = 30.81$, $P < 0.001$, $df = 69$], pasture 2 [$F = 16.75$, $P < 0.001$, $df = 61$], pasture 3 [$F = 17.39$, $P < 0.001$, $df = 87$]), upland 1 ($F = 10.73$, $P < 0.001$, $df = 62$), and all wetland age classes except for 3 (non-mined wetland [$F = 10.10$, $P < 0.001$, $df = 47$], wetland 1 [$F = 12.26$, $P < 0.001$, $df = 55$], and wetland 2 [$F = 4.88$, $P = 0.03$, $df = 44$]). The mean/point bird diversity of the non-mined pasture points was greater than that of upland 1 ($F = 4.97$, $P = 0.03$, $df = 40$), and all wetland points except age class 3 (non-mined wetland [$F = 8.72$, $P < 0.001$, $df = 25$], wetland 1 [$F = 7.89$, $P < 0.001$, $df = 33$], and wetland 2 [$F = 5.08$, $P = 0.04$, $df = 22$]). Pasture 3 points had greater mean/point bird diversity than the non-mined wetland points ($F = 5.98$, $P = 0.02$, $df = 47$) and wetland 2 points ($F = 4.60$, $P = 0.04$, $df = 44$). The non-mined upland points had a greater mean/point bird diversity than that of all of the reclaimed pasture points (pasture 1 [$F = 32.92$, $P < 0.001$, $df = 50$], pasture 2 [$F = 17.00$, $P < 0.001$, $df = 42$], pasture 3 [$F = 16.04$, $P < 0.001$, $df = 68$]), and all of the wetland points with the exception of the wetland 3 age class (non-mined wetland [$F = 14.29$, $P < 0.001$, $df = 28$], wetland 1 [$F = 15.21$, $P < 0.001$, $df = 36$], and wetland 2 [$F = 7.79$, $P = 0.01$, $df = 25$]). Upland 2 points had a greater mean/point bird diversity than points in pasture 1 ($F = 9.67$, $P < 0.001$, $df = 33$), and all wetland points except those in wetland 3 (non-mined wetland [$F = 7.46$, $P = 0.02$, $df = 11$], wetland 1 [$F = 5.07$, $P = 0.04$, $df = 19$], and wetland 2 [$F = 6.34$, $P = 0.04$, $df = 8$]). Upland 3 points had a greater mean/point bird diversity than all of the reclaimed pasture points (pasture 1 [$F = 15.11$, $P < 0.001$, $df = 34$], pasture 2 [$F = 7.34$, $P = 0.01$, $df = 26$], and pasture 3 [$F = 6.22$, $P = 0.02$, $df = 52$]), and all wetland points except those in wetland 3 (non-mined wetland [$F = 8.97$, $P = 0.01$, $df = 12$], wetland 1 [$F = 8.04$, $P = 0.01$, $df = 20$], and wetland 2 [$F = 6.05$, $P = 0.04$, $df = 9$]). Wetland 3 had greater mean bird diversity than all of the reclaimed pasture points (pasture 1 [$F = 25.21$, $P < 0.001$, $df = 34$], pasture 2 [$F = 12.55$, $P < 0.001$, $df = 26$], and pasture 3 [$F = 12.79$, $P < 0.001$, $df = 52$]), and upland 1 points ($F = 8.91$, $P < 0.001$, $df = 27$).

*Richness.*— Tables 8 and 9 and display the mean/point richness of the different age classes and vegetation types after age class pooling, respectively, for 2003 and 2004. In the 2003 season age class comparisons, significant differences in mean/point richness were found between several age classes among the different vegetation types. Non-mined bottomland points had greater bird mean/point richness than bottomland 1 ($F = 4.97$, $P = 0.03$, $df = 31$), and bottomland 3 ($F = 16.19$, $P < 0.001$, $df = 31$). Non-mined pasture points were greater in mean/point bird richness than pasture 1 points ($F = 13.79$, $P < 0.001$, $df = 26$), and pasture 3 points ($F = 4.41$, $P = 0.04$, $df = 65$). The non-mined upland points were significantly greater in mean/point bird richness than the upland 1 points ($F = 19.73$, $P < 0.001$, $df = 43$), and the upland 2 points ($F = 8.42$, $P < 0.001$, $df = 32$). Finally, wetland 1 points had greater mean/point bird richness than wetland 2 ($F = 5.18$, $P = 0.04$, $df = 12$; Table 8; Fig 12).

Table 8. Mean bird richness (number of species/point) of non-mined and reclaimed areas by age class at Big Brown Mine, Freestone County, Texas for 2003 and 2004. Groups that share the same capital letter(s) among the same vegetation groups are not statistically ($P$ < 0.05) different.

| 2003 | | | 2004 | | |
|---|---|---|---|---|---|
| Age class[a] | Richness (number of species/point) | | Age class[a] | Richness (number of species/point) | |
| | $\bar{x}$ ± SE | $n$ | | $\bar{x}$ ± SE | $n$ |
| NMBL | 9.00 ± 0.37 [A] | 26 | NMBL[A] | 8.32 ± 0.43 [A] | 26 |
| BL1 | 7.00 ± 1.07 [B] | 7 | BL1 [A] | 8.43 ± 1.49 [A] | 7 |
| BL2 | 7.20 ± 1.36 [AB] | 5 | BL2 [A] | 6.60 ± 0.98 [A] | 5 |
| BL3 | 5.71 ± 0.78 [B] | 8 | BL3 [A] | 8.00 ± 0.82 [A] | 8 |
| NMUL | 8.88 ± 0.48 [A] | 24 | NMUL | 8.00 ± 0.42 [A] | 24 |
| UL1 | 6.00 ± 0.39 [B] | 19 | UL1 | 5.90 ± 0.53 [B] | 19 |
| UL2 | 5.88 ± 1.06 [B] | 8 | UL2 | 6.35 ± 0.88 [AB] | 8 |
| UL3 | 7.11 ± 0.98 [AB] | 9 | UL3 | 7.44 ± 0.78 [AB] | 9 |
| NMP | 7.46 ± 0.43 [A] | 22 | NMP | 7.50 ± 0.57 [A] | 22 |
| P1 | 5.46 ± 1.52 [B] | 27 | P1 | 4.42 ± 0.33 [B] | 27 |
| P2 | 6.22 ± 0.60 [AB] | 17 | P2 | 4.83 ± 0.38 [B] | 17 |
| P3 | 6.21 ± 0.36 [B] | 44 | P3 | 5.77 ± 0.27 [B] | 44 |
| NMWL | 7.67 ± 1.20 [AB] | 3 | NMWL | 4.33 ± 1.45 [A] | 3 |
| WL1 | 7.33 ± 0.28 [A] | 12 | WL1 | 4.75 ± 0.41 [A] | 12 |
| WL2 | 5.00 ± 0.00 [B] | 1 | WL2 | 3.00 ± 0.00 [A] | 1 |
| WL3 | 8.00 ± 0.65 [AB] | 8 | WL3 | 8.44 ± 0.58 [B] | 8 |

[a]BL = bottomland forest, UL = upland forest, P = pasture, WL = wetland, [b]NM = non-mined, 1 = 0–5 years reclaimed, 2 = 10–15 years reclaimed, 3 = 20+ years reclaimed

Table 9. Mean bird richness (number of species/point) of non-mined and reclaimed areas by vegetation type at Big Brown Mine, Freestone County, Texas for 2003 and 2004. Groups that share the same capital letter(s) among the same vegetation groups are not statistically ($P$ < 0.05) different.

| 2003 | | | 2004 | | |
|---|---|---|---|---|---|
| Vegetation type[a] | Richness (number of species/point) | | Vegetation type[a] | Richness (number of species/point) | |
| | $\bar{x}$ ± SE | $n$ | | $\bar{x}$ ± SE | $n$ |
| NMBL | 9.00 ± 0.37 [A] | 26 | BL pooled | 6.13 ± 0.39 [AC] | 46 |
| BL123 pooled | 6.58 ± 0.59 [BCE] | 20 | | | |
| NMUL | 8.88 ± 0.48 [A] | 24 | NMUL | 8.00 ± 0.42 [B] | 24 |
| UL123 pooled | 6.25 ± 0.39 [CDE] | 17 | UL123 pooled | 6.39 ± 0.40 [C] | 17 |
| NMP | 7.46 ± 0.43 [BCE] | 22 | NMP | 7.50 ± 0.57 [B] | 22 |
| P123 pooled | 5.99 ± 0.53 [BD] | 88 | P123 pooled | 5.50 ± 0.23 [DE] | 88 |
| WL1 | 7.33 ± 0.28 [BCD] | 12 | WL3 | 8.44 ± 0.58 [B] | 8 |
| NMWL23 pooled | 7.33 ± 0.29 [AE] | 12 | NMWL12 pooled | 4.56 ± 0.40 [DE] | 16 |

[a]BL = bottomland forest, UL = upland forest, P = pasture, WL = wetland, NM = non-mined, 1 = 0–5 years reclaimed, 2 = 10–15 years reclaimed, 3 = 20+ years reclaimed

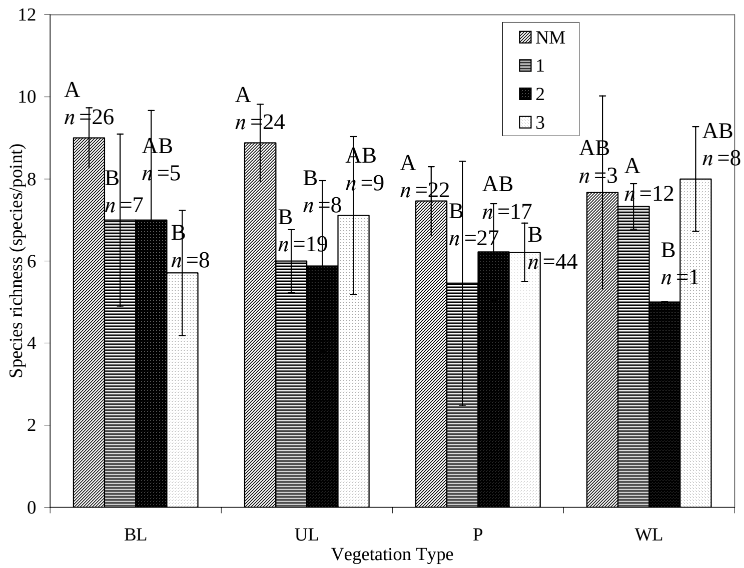



Fig. 12. Differences (error bars represent a 95% confidence interval) in mean bird richness (# species/point) among age classes (NM = non-mined, 1 = reclaimed 0-5 years, 2 = reclaimed 10-15 years, 3 = reclaimed 20+ years, BL = bottomland, UL = upland, P = pasture, WL = wetland) on non-mined and reclaimed areas at Big Brown Mine, Freestone County, Texas for 2003. Bars that share the same capital letter(s) among the same vegetation groups are not statistically (*P* < 0.05) different.

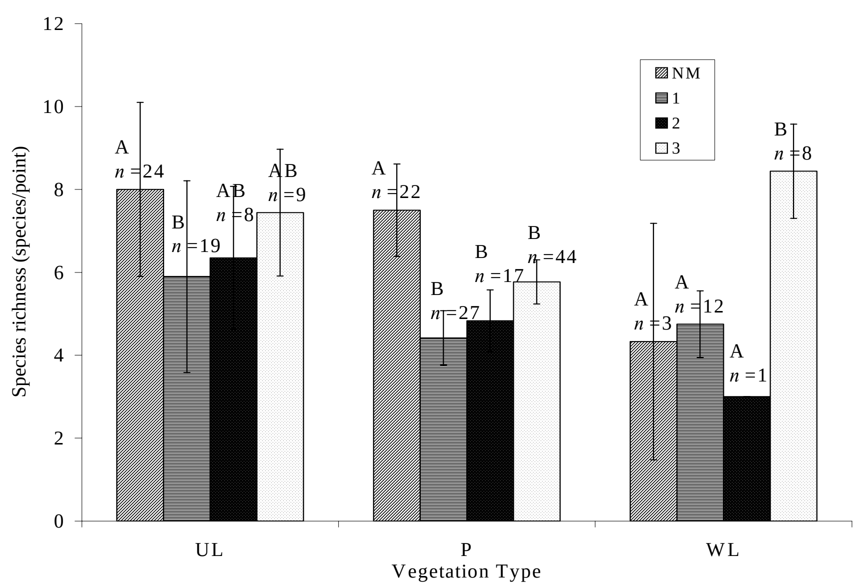



Fig. 13. Differences (error bars represent a 95% confidence interval) in mean bird richness (# species/point) among age classes (NM = non-mined, 1 = reclaimed 0–5 years, 2 = reclaimed 10–15 years, 3 = reclaimed 20+ years, UL = upland, P = pasture, WL = wetland) on non-mined and reclaimed areas at Big Brown Mine, Freestone County, Texas for 2004.

In comparing mean/point bird richness for the vegetation types of the 2003 season, the following significant differences were found (Table 9). Non-mined bottomland points had higher mean/point bird richness than all pasture points (non-mined [$F = 7.51$, $P < 0.001$, $df = 46$] and reclaimed 1, 2, and 3 [$F = 37.05$, $P < 0.001$, $df = 112$]), as well as all reclaimed upland points ($F = 23.79$, $P < 0.001$, $df = 60$), and wetland 1 ($F = 8.33$, $P < 0.001$, $df = 36$). The non-mined upland points had greater mean/point bird richness than the reclaimed bottomland points 1, 2, and 3 ($F = 9.33$, $P < 0.001$, $df = 43$), all pasture points (non-mined pasture [$F = 4.82$, $P = 0.03$, $df = 46$] and reclaimed pasture 1, 2, and 3 [$F = 30.96$, $P < 0.001$, $df = 112$]), and wetland 1 ($F = 4.55$, $P = 0.04$, $df = 36$). Finally, pooled non-mined, 2, and 3 wetland had a greater mean/point bird richness than reclaimed pasture points 1, 2, and 3 ($F = 6.62$, $P = 0.01$, $df = 100$; Fig. 14).

In the 2004 season, there was no difference in mean/point bird richness between age classes among the bottomland vegetation class (Table 8). However, in the pasture vegetation type, the non-mined pasture points had significantly greater mean/point bird richness than the reclaimed points (pasture 1 [$F = 23.39$, $P < 0.001$, $df = 47$], pasture 2 [$F = 13.79$, $P < 0.001$, $df = 39$], pasture 3 [$F = 9.68$, $P < 0.001$, $df = 65$]). Pasture 3 was also greater in mean/point bird richness than pasture 1 ($F = 9.55$, $P < 0.001$, $df = 69$). Only one significant difference was found among mean/point bird richness in the upland vegetation type. The non-mined upland type had greater mean/point bird richness than the upland 1 class ($F = 9.96$, $P < 0.001$, $df = 43$; Fig. 13). Among the wetland vegetation type, wetland 3 had greater mean/point richness than all other wetland age class

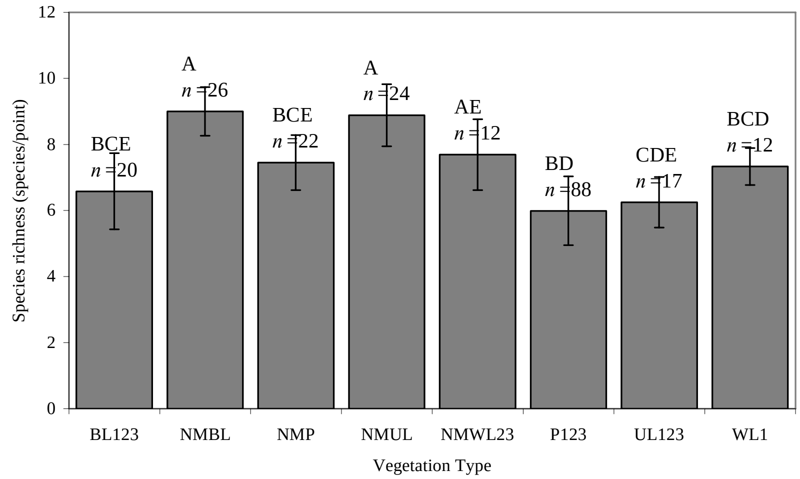



Fig. 14. Differences (error bars represent a 95% confidence interval) in mean bird richness (# species/point) among vegetation types (NM = non-mined, 1 = reclaimed 0–5 years, 2 = reclaimed 10–15 years, 3 = reclaimed 20+ years, BL = bottomland, UL = upland, P = pasture, WL = wetland) on non-mined and reclaimed areas at Big Brown Mine, Freestone County, Texas for 2003. Bars that share the same capital letter(s) among the same vegetation groups are not statistically ($P < 0.05$) different.

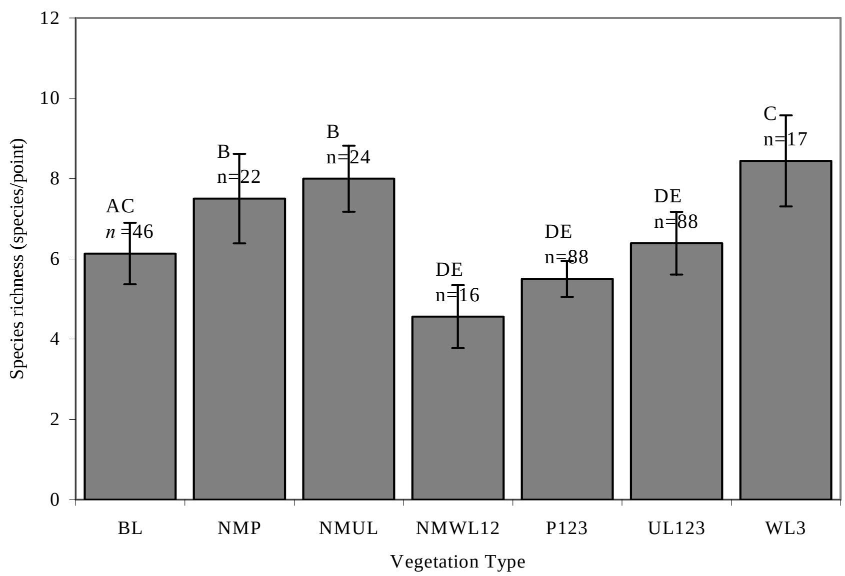



Fig. 15. Differences (error bars represent a 95% confidence interval) in mean bird richness (# species/point) among vegetation types (NM = non-mined, 1 = reclaimed 0–5 years, 2 = reclaimed 10–15 years, 3 = reclaimed 20+ years, BL = bottomland, UL = upland, P = pasture, WL = wetland) on non-mined and reclaimed areas at Big Brown Mine, Freestone County, Texas for 2004.

categories (non-mined wetland [$F = 10.31$, $P = 0.01$, $df = 11$], wetland 1 [$F = 28.7$, $P < 0.001$, $df = 20$], and wetland 2 [$F = 8.81$, $P = 0.02$, $df = 9$]).

In comparing mean/point bird richness of vegetation types for 2004, several significant differences were found (Table 9). Pooled bottomland points had greater mean/point bird richness than pasture 1 ($F = 9.73$, $P < 0.001$, $df = 101$), and the pooled non-mined wetland and wetland 1 and 2 points ($F = 5.36$, $P = 0.02$, $df = 91$). Non-mined pasture points had greater mean/point bird richness than that of the pooled bottomland points ($F = 4.66$, $P = 0.03$, $df = 97$) and the pooled non-mined wetland and wetland 1 and 2 points ($F = 15.35$, $P < 0.001$, $df = 37$). Mean/point bird richness of the non-mined upland points was greater than several other vegetation types, including the pooled bottomland points ($F = 10.58$, $P < 0.001$, $df = 100$), pasture 1 points ($F = 44.8$, $P < 0.001$, $df = 50$), the pooled pasture 2 and 3 points ($F = 31.39$, $P < 0.001$, $df = 86$), and the pooled wetland non-mined, 1, and 2 points ($F = 31.24$, $P < 0.001$, $df = 40$). The mean/point bird richness of the pooled reclaimed upland points 1, 2, and 3 was greater than that of pasture 1 points ($F = 12.92$, $P < 0.001$, $df = 61$), pasture 2 and 3 points ($F = 4.38$, $P = 0.04$, $df = 97$), and the wetland non-mined, 1 and 2 points ($F = 7.81$, $P = 0.01$, $df = 51$). Finally, the wetland 3 points had a greater mean/point bird richness than the pooled bottomland points ($F = 6.7$, $P = 0.01$, $df = 84$), pasture 1 points ($F = 36.95$, $P < 0.001$, $df = 34$), pooled pasture 2 and 3 points ($F = 21.4$, $P < 0.001$, $df = 70$), and the pooled reclaimed upland points 1, 2, and 3 ($F = 5.87$, $P = 0.02$, $df = 44$; Fig. 15).

*Nesting guild density.*—After separating species into nesting guilds (Appendix A) mean/point densities of each guild were compared between age classes (See Tables

10 and 11 for density listing). Several significant differences were found among age classes between mean/point densities of several different nesting guilds in 2003 (Table 10). In the brush nesting guild mean/point density was greater in the non-mined upland points than the upland 2 ($F$ = 12.80, $P$ < 0.001, $df$ = 32) and upland 3 ($F$ = 5.17, $P$ = 0.03, $df$ = 33). The brush nesting mean/point density was greater in non-mined wetland points than wetland 1 ($F$ = 4.86, $P$ = 0.04 $df$ = 14) and wetland 3 ($F$ = 8.35, $P$ = 0.02, $df$ = 11). Mean/point density in wetland 2 was greater than in wetland 1 ($F$ = 6.23, $P$ = 0.03, $df$ = 12) and wetland 3 ($F$ = 9.60, $P$ = 0.02, $df$ = 8).

The canopy nesting guild mean/point density was greater in non-mined pasture points than pasture 1 ($F$ = 22.38, $P$ < 0.001, $df$ = 46), pasture 2 (f = 7.02, $P$ = 0.01, $df$ = 39) and pasture 3 ($F$ = 12.88, $P$ < 0 0.001, $df$ = 65). Mean/point density in pasture 3 was greater than mean density in pasture 1 [($F$ = 4.81, $P$ = 0.03, $df$ = 68); Table 10].

The cavity nesting guild mean/point density was greater in non-mined bottomland points than in bottomland 1 ($F$ = 12.04, $P$ < 0.001, $df$ = 31) and bottomland 2 points ($F$ = 6.82, $P$ = 0.01, $df$ = 29). Mean/point density also was greater in non-mined upland points than upland 1 ($F$ = 34.18, $P$ < 0.001, $df$ = 43), upland 2 ($F$ = 6.42, $P$ = 0.02, $df$ = 32), and upland 3 points ($F$ = 10.31, $P$ = 0.003, $df$ = 33). Upland 1 mean/point density was less than upland 2 ($F$ = 10.56, $P$ < 0.001, $df$ = 26), and upland 3 points [($F$ = 7.43, $P$ = 0.01, $df$ = 27); Table 10].

The ground nesting guild had several significant differences in mean/point density among age classes for 2003. Non-mined bottomland mean/point density was less than mean/point density in bottomland 1 ($F$ = 63, $P$ < 0.001, $df$ = 31), bottomland 2 ($F$ =

Table 10. Mean nesting guild density (individuals/ha) of non-mined and reclaimed areas by age class at Big Brown Mine, Freestone County, Texas for 2003. Groups that share the same capital letter(s) among the same vegetation groups are not statistically ($P$ < 0.05) different.

| Age class[a] | Nesting guild | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aquatic[b] | | Brush | | Canopy | | Cavity | | Colonial | | Ground | |
| | $\bar{x} \pm SE$ | $n$ | $\bar{x} \pm SE$ | $n$ | $\bar{x} \pm SE$ | $n$ | $\bar{x} \pm SE$ | $n$ | $\bar{x} \pm SE$ | $n$ | $\bar{x} \pm SE$ | $n$ |
| NMBL | 0.00 ± 0.00 $^{A}$ | 25 | 0.38 ± 0.14 $^{A}$ | 25 | 0.58 ± 0.81 $^{A}$ | 25 | 0.20 ± 0.11 $^{A}$ | 25 | 0.00 ± 0.02 $^{A}$ | 25 | 0.02 ± 0.04 $^{A}$ | 25 |
| BL1 | 0.00 ± 0.00 $^{A}$ | 7 | 0.39 ± 0.24 $^{A}$ | 7 | 0.35 ± 0.16 $^{A}$ | 7 | 0.04 ± 0.09 $^{B}$ | 7 | 0.02 ± 0.06 $^{A}$ | 7 | 0.40 ± 0.24 $^{B}$ | 7 |
| BL2 | 0.00 ± 0.00 $^{A}$ | 5 | 0.34 ± 0.24 $^{A}$ | 5 | 0.31 ± 0.25 $^{A}$ | 5 | 0.06 ± 0.10 $^{B}$ | 5 | 0.00 ± 0.00 $^{A}$ | 5 | 0.22 ± 0.19 $^{BC}$ | 5 |
| BL3 | 0.00 ± 0.00 $^{A}$ | 7 | 0.21 ± 0.17 $^{A}$ | 7 | 0.30 ± 0.21 $^{A}$ | 7 | 0.11 ± 0.13 $^{AB}$ | 7 | 0.04 ± 0.12 $^{A}$ | 7 | 0.10 ± 0.17 $^{C}$ | 7 |
| NMUL | 0.00 ± 0.00 $^{A}$ | 25 | 0.34 ± 0.13 $^{A}$ | 25 | 0.46 ± 0.13 $^{A}$ | 25 | 0.20 ± 0.15 $^{A}$ | 25 | 0.01 ± 0.03 $^{A}$ | 25 | 0.01 ± 0.03 $^{A}$ | 25 |
| UL1 | 0.00 ± 0.02 $^{A}$ | 19 | 0.28 ± 0.20 $^{AB}$ | 19 | 0.22 ± 0.44 $^{A}$ | 19 | 0.00 ± 0.00 $^{B}$ | 19 | 0.07 ± 0.18 $^{A}$ | 19 | 0.78 ± 0.57 $^{B}$ | 19 |
| UL2 | 0.00 ± 0.00 $^{A}$ | 8 | 0.15 ± 0.15 $^{B}$ | 8 | 0.42 ± 0.34 $^{A}$ | 8 | 0.06 ± 0.08 $^{C}$ | 8 | 0.00 ± 0.00 $^{A}$ | 8 | 0.07 ± 0.06 $^{C}$ | 8 |
| UL3 | 0.00 ± 0.00 $^{A}$ | 9 | 0.23 ± 0.14 $^{B}$ | 9 | 0.29 ± 0.14 $^{A}$ | 9 | 0.04 ± 0.06 $^{C}$ | 9 | 0.10 ± 0.20 $^{A}$ | 9 | 0.14 ± 0.12 $^{C}$ | 9 |
| NMP | 0.00 ± 0.00 $^{A}$ | 22 | 0.21 ± 0.11 $^{A}$ | 22 | 0.40 ± 0.24 $^{A}$ | 22 | 0.13 ± 0.11 $^{A}$ | 22 | 0.10 ± 0.17 $^{A}$ | 22 | 0.10 ± 0.11 $^{A}$ | 22 |
| P1 | 0.00 ± 0.00 $^{A}$ | 25 | 0.29 ± 0.65 $^{A}$ | 25 | 0.12 ± 0.16 $^{B}$ | 25 | 0.00 ± 0.00 $^{A}$ | 25 | 0.09 ± 0.16 $^{A}$ | 25 | 0.57 ± 0.36 $^{B}$ | 25 |
| P2 | 0.00 ± 0.00 $^{A}$ | 18 | 0.19 ± 0.23 $^{A}$ | 18 | 0.22 ± 0.18 $^{BC}$ | 18 | 0.03 ± 0.05 $^{A}$ | 18 | 0.11 ± 0.22 $^{A}$ | 18 | 0.41 ± 0.02 $^{BC}$ | 18 |
| P3 | 0.00 ± 0.00 $^{A}$ | 44 | 0.14 ± 0.12 $^{A}$ | 44 | 0.21 ± 0.18 $^{C}$ | 44 | 0.14 ± 0.59 $^{A}$ | 44 | 0.18 ± 0.77 $^{A}$ | 44 | 0.32 ± 0.33 $^{C}$ | 44 |

Table 10 continued.

| Age class[a] | Nesting guild | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aquatic[b] | | Brush | | Canopy | | Cavity | | Colonial | | Ground | |
| | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* |
| NMWL | 0.00 ± 0.00 A | 3 | 0.42 ± 0.09 A | 3 | 0.26 ± 0.16 A | 3 | 0.16 ± 0.00 A | 3 | 0.00 ± 0.00 A | 3 | 0.08 ± 0.14 A | 3 |
| WL1 | 0.06 ± 0.16 A | 12 | 0.27 ± 0.11 B | 12 | 0.15 ± 0.16 A | 12 | 0.03 ± 0.05 A | 12 | 0.18 ± 0.19 A | 12 | 0.64 ± 0.59 A | 12 |
| WL2 | 0.00 ± 0.00 A | 1 | 0.55 ± 0.00 A | 1 | 0.16 ± 0.00 A | 1 | 0.00 ± 0.00 A | 1 | 0.00 ± 0.00 A | 1 | 0.63 ± 0.00 A | 1 |
| WL3 | 0.00 ± 0.00 A | 9 | 0.24 ± 0.10 B | 9 | 0.36 ± 0.29 A | 9 | 0.92 ± 2.61 A | 9 | 0.20 ± 0.28 A | 9 | 0.19 ± 0.14 A | 9 |

[a]NM = non-mined, 1 = 0–5 years reclaimed, 2 = 10–15 years reclaimed, 3 = 20+ years reclaimed, BL = bottomland forest, UL = upland forest, P = pasture, WL = wetland, [b]Nesting guilds

Table 11. Mean nesting guild density (individuals/ha) on non-mined and reclaimed land by age class at Big Brown Mine, Freestone County, Texas for 2004. Groups that share the same capital letter(s) among the same vegetation groups are not statistically ($P < 0.05$) different.

| Age class[a] | Nesting guild | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aquatic[b] | | Brush | | Canopy | | Cavity | | Colonial | | Ground | |
| | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* |
| NMBL | 0.00 ± 0.00 A | 25 | 0.38 ± 0.51 A | 25 | 0.41 ± 0.28 A | 25 | 0.17 ± 0.12 A | 25 | 0.00 ± 0.01 A | 25 | 0.03 ± 0.10 AC | 25 |
| BL1 | 0.00 ± 0.00 A | 7 | 0.39 ± 0.06 A | 7 | 0.30 ± 0.18 A | 7 | 0.02 ± 0.04 A | 7 | 0.01 ± 0.03 A | 7 | 0.36 ± 0.19 B | 7 |
| BL2 | 0.00 ± 0.00 A | 5 | 0.39 ± 0.41 A | 5 | 0.30 ± 0.07 A | 5 | 0.11 ± 0.10 A | 5 | 0.00 ± 0.00 A | 5 | 0.13 ± 0.12 C | 5 |
| BL3 | 0.00 ± 0.00 A | 7 | 0.25 ± 0.20 A | 7 | 0.22 ± 0.05 A | 7 | 0.24 ± 0.30 A | 7 | 0.13 ± 0.29 A | 7 | 0.20 ± 0.37 ABC | 7 |

Table 11 continued.

| Age class[a] | Nesting guild | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aquatic[b] | | Brush | | Canopy | | Cavity | | Colonial | | Ground | |
| | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* | $\bar{x} \pm SE$ | *n* |
| NMUL | 0.00 ± 0.00 A | 25 | 0.23 ± 0.12 A | 25 | 0.39 ± 0.21 A | 25 | 0.21 ± 0.14 A | 25 | 0.00 ± 0.00 A | 25 | 0.09 ± 0.20 A | 25 |
| UL1 | 0.01 ± 0.04 A | 19 | 0.30 ± 0.25 A | 19 | 0.13 ± 0.10 B | 19 | 0.00 ± 0.02 B | 19 | 0.04 ± 0.07 A | 19 | 0.53 ± 0.29 B | 19 |
| UL2 | 0.00 ± 0.00 A | 8 | 0.18 ± 0.12 A | 8 | 0.30 ± 0.27 A | 8 | 0.02 ± 0.06 BC | 8 | 0.02 ± 0.06 A | 8 | 0.23 ± 0.17 A | 8 |
| UL3 | 0.00 ± 0.00 A | 9 | 0.31 ± 0.20 A | 9 | 0.36 ± 0.23 A | 9 | 0.09 ± 0.07 C | 9 | 0.09 ± 0.26 A | 9 | 0.12 ± 0.11 A | 9 |
| NMP | 0.00 ± 0.00 A | 22 | 0.34 ± 0.32 A | 22 | 0.36 ± 0.32 A | 22 | 0.07 ± 0.08 A | 22 | 0.05 ± 0.11 A | 22 | 0.21 ± 0.26 A | 22 |
| P1 | 0.00 ± 0.01 A | 25 | 0.15 ± 0.20 A | 25 | 0.06 ± 0.09 B | 25 | 0.00 ± 0.00 B | 25 | 0.03 ± 0.05 A | 25 | 0.49 ± 0.29 B | 25 |
| P2 | 0.00 ± 0.00 A | 18 | 0.11 ± 0.14 A | 18 | 0.13 ± 0.13 B | 18 | 0.02 ± 0.03 C | 18 | 0.21 ± 0.48 A | 18 | 0.43 ± 0.59 AB | 18 |
| P3 | 0.00 ± 0.00 A | 44 | 0.20 ± 0.41 A | 44 | 0.23 ± 0.35 A | 44 | 0.02 ± 0.04 C | 44 | 0.16 ± 0.28 A | 44 | 0.47 ± 0.37 B | 44 |
| NMWL | 0.00 ± 0.00 A | 3 | 0.24 ± 0.08 A | 3 | 0.13 ± 0.16 A | 3 | 0.05 ± 0.09 A | 3 | 0.03 ± 0.04 A | 3 | 0.42 ± 0.40 A | 3 |
| WL1 | 0.00 ± 0.00 A | 12 | 0.21 ± 0.22 A | 12 | 0.07 ± 0.12 A | 12 | 0.03 ± 0.06 A | 12 | 0.05 ± 0.10 A | 12 | 0.28 ± 0.21 A | 12 |
| WL2 | 1.10 ± 0.00 B | 1 | 0.39 ± 0.00 A | 1 | 0.00 ± 0.00 A | 1 | 0.00 ± 0.00 A | 1 | 0.08 ± 0.00 A | 1 | 0.00 ± 0.00 A | 1 |
| WL3 | 0.01 ± 0.03 A | 9 | 0.18 ± 0.10 A | 9 | 0.22 ± 0.10 A | 9 | 0.07 ± 0.10 A | 9 | 0.19 ± 0.30 A | 9 | 0.36 ± 0.27 A | 9 |

[a]NM = non-mined, 1 = 0–5 years reclaimed, 2 = 10–15 years reclaimed, 3 = 20+ years reclaimed, BL = bottomland forest, UL = upland forest, P = pasture, WL = wetland, [b]Nesting guilds

27.38, $P < 0.001$, $df = 29$), and in bottomland 3 points ($F = 5.46$, $P = 0.03$, $df = 31$). Ground nesting guild mean/point density in bottomland 1 points was greater than in bottomland 3 points ($F = 6.95$, $P = 0.02$, $df = 13$). Mean/point density in non-mined pasture points was less than mean/point density in pasture 1 ($F = 35.05$, $P < 0.001$, $df = 46$), pasture 2 ($F = 29.42$, $P < 0.001$, $df = 39$), and pasture 3 points ($F = 9.04$, $P < 0.001$, $df = 65$). Mean/point density was greater in pasture 1 than in pasture 3 points ($F = 8.95$, $P < 0.001$, $df = 68$). Ground nesting guild mean/point density was greater in upland 1 points than in non-mined upland ($F = 45.46$, $P < 0.001$, $df = 43$), upland 2 ($F = 12.10$, $P < 0.005$, $df = 26$), and upland 3 points ($F = 10.88$, $P < 0.001$, $df = 27$). Mean/point density in non-mined upland points was also less than mean/point density in upland 2 ($F = 11.66$, $P < 0.001$, $df = 32$) and upland 3 points [($F = 24.19$, $P < 0.001$, $df = 33$), Table 10].

In 2004 several significant differences existed among age classes between mean/point density within certain nesting guilds (Table 11). The aquatic nesting guild mean/point density was greater in wetland 2 points than wetland 3 points ($F = 1562.5$, $P < 0.001$, $df = 9$).

The canopy nesting guild mean/point density was greater in non-mined pasture than in pasture 1 ($F = 21.06$, $P < 0.001$, $df = 46$), and pasture 2 points ($F = 8.71$, $P < 0.001$, $df = 39$). Mean/point density in pasture 3 was greater than in pasture 1 ($F = 5.37$, $P = 0.02$, $df = 68$). Mean/point density in upland 1 points was less than mean/point density in non-mined upland ($F = 24.44$, $P < 0.001$, $df = 43$), upland 2 ($F = 6.20$, $P = 0.02$, $df = 29$), and in upland 3 points [($F = 13.88$, $P < 0.001$, $df = 27$), Table 11].

The cavity nesting guild mean/point density was greater in non-mined pasture points than in pasture 1 ($F$ = 17.39, $P$ < 0.001, $df$ = 46), pasture 2 ($F$ = 6.02, $P$ = 0.02, $df$ = 39), and in pasture 3 points ($F$ = 11.08, $P$ < 0.001, $df$ = 65). Mean/point density in pasture 1 points was less than in pasture 2 ($F$ = 6.81, $P$ = 0.01, $df$ = 42), and in pasture 3 points ($F$ = 4.70, $P$ = 0.03, $df$ = 68). Cavity nesting guild mean/point density was greater in non-mined upland than in upland 1 ($F$ = 38.94, $P$ < 0.001, $df$ = 43), upland 2 ($F$ = 13.38, $P$ < 0.001, $df$ = 32), and in upland 3 points ($F$ = 6.04, $P$ = 0.02, $df$ = 33). Mean/point density in upland 3 points was greater than in upland 1 points [($F$ = 22.7, $P$ < 0.001, $df$ = 27) Table 11].

Mean/point density in the ground nesting guild was greater in bottomland 1 points than in non-mined bottomland ($F$ = 37.91, $P$ < 0.001, $df$ = 31), and in bottomland 2 ($F$ = 6.00, $P$ = 0.03, $df$ = 11). Mean/point density in non-mined pasture was less than mean/point density in pasture 1 ($F$ = 11.75, $P$ < 0.001, $df$ = 46) and in pasture 3 points ($F$ = 8.67, $P$ < 0.001, $df$ = 65). Mean/point density in the upland 1 points was greater than mean/point density in non-mined upland ($F$ = 35.96, $P$ < 0.001, $df$ = 43), upland 2 ($F$ = 7.43, $P$ = 0.01, $df$ = 26), and upland 3 points [($F$ = 15.91, $P$ < 0.001, $df$ = 27); Table 11].

When comparing nesting guild mean/point densities among vegetation types for 2003, several significant differences were found (Table 12). In the aquatic nesting guild mean/point density was greater in the pooled wetland points than the pooled bottomland points ($F$ = 10.29, $P$ = 0.002, $df$ = 176).

In the brush nesting guild, pooled bottomland mean/point point density was greater than pooled mean/point density in pasture points ($F$ = 8.47, $P$ = 0.004, $df$ = 152),

Table 12. Mean nesting guild density (individuals/ha) on non-mined and reclaimed areas by vegetation type at Big Brown Mine, Freestone County, Texas for 2003. Groups that share the same capital letter(s) among the same vegetation groups are not statistically ($P < 0.05$) different.

| Nesting guild | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aquatic[b] | | | Brush | | | Canopy | | | Cavity | | | Colonial | | | Ground | | |
| Veg. type | $\bar{x} \pm SE$ | *n* | Veg. type | $\bar{x} \pm SE$ | *n* | Veg. type | $\bar{x} \pm SE$ | *n* | Veg. type | $\bar{x} \pm SE$ | *n* | Veg. type | $\bar{x} \pm SE$ | *n* | Veg. type | $\bar{x} \pm SE$ | *n* |
| | | | | | | | | | NMBL | $0.20 \pm 0.11^{A}$ | 25 | | | | NMBL | $0.02 \pm 0.04^{A}$ | 25 |
| BL | $0.00 \pm 0.00^{A}$ | 44 | BL | $0.35 \pm 0.18^{ACEF}$ | 44 | BL | $0.47 \pm 0.63^{AB}$ | 44 | BL123 | $0.07 \pm 0.11^{A}$ | 19 | BL | $0.01 \pm 0.05^{A}$ | 44 | BL1 | $0.39 \pm 0.24^{BMN}$ | 7 |
| | | | | | | | | | | | | | | | BL23 | $0.15 \pm 0.18^{C}$ | 12 |
| | | | NMUL | $0.34 \pm 0.13^{ACEF}$ | 25 | | | | NMUL | $0.20 \pm 0.15^{A}$ | 25 | | | | NMUL | $0.01 \pm 0.03^{ADHIJ}$ | 25 |
| UL | $0.00 \pm 0.01^{AB}$ | 60 | | | | UL | $0.36 \pm 0.30^{AB}$ | 61 | UL1 | $0.0 \pm 0.00^{A}$ | 19 | UL | $0.04 \pm 0.13^{A}$ | 61 | UL1 | $0.78 \pm 0.57^{BEKO}$ | 19 |
| | | | UL123 | $0.24 \pm 0.18^{DEF}$ | 36 | | | | UL23 | $0.05 \pm 0.07^{A}$ | 17 | | | | UL23 | $0.11 \pm 0.10^{CFL}$ | 17 |
| | | | | | | NMP | $0.40 \pm 0.24^{B}$ | 22 | | | | | | | NMP | $0.10 \pm 0.11^{CHO}$ | 22 |
| P | $0.00 \pm 0.00^{AB}$ | 109 | P | $0.20 \pm 0.34^{BDEF}$ | 109 | P12 | $0.16 \pm 0.17^{C}$ | 43 | P | $0.09 \pm 0.38^{A}$ | 109 | P | $0.13 \pm 0.51^{A}$ | 109 | P1 | $0.57 \pm 0.36^{IDEFM}$ | 25 |
| | | | | | | P3 | $0.21 \pm 0.17^{D}$ | 44 | | | | | | | P23 | $0.34 \pm 0.31^{JKLN}$ | 62 |
| | | | NMWL | $0.42 \pm 0.09^{E}$ | 3 | | | | | | | | | | | | |
| WL | $0.03 \pm 0.12^{B}$ | 24 | WL13 | $0.25 \pm 0.10^{BD}$ | 21 | WL | $0.24 \pm 0.23^{ACD}$ | 25 | WL | $0.36 \pm 1.56^{A}$ | 25 | WL | $0.16 \pm 0.22^{A}$ | 25 | WL | $0.41 \pm 0.48^{BCDJ}$ | 25 |
| | | | WL2 | $0.55 \pm 0.00^{F}$ | 1 | | | | | | | | | | | | |

[a]BL = bottomland forest, UL = upland forest, P = pasture, WL = wetland, [b]Nesting guilds

pooled upland 1, 2, 3 points (*F* = 7.99, *P* = 0.01, *df* = 79), and pooled wetland 1 and 3 points (*F* = 5.27, *P* = 0.03, *df* = 64). Mean/point density of non-mined upland points was greater than pooled mean/point density of pasture points (*F* = 4.59, *P* = 0.03, *df* = 133), and pooled wetland 1 and 3 [(*F* = 6.48, *P* = 0.02, *df* = 45), Table 12].

The canopy nesting guild had higher mean/point density in pooled bottomland points than pooled pasture 1 and 2 points (*F* = 9.49, *P* = 0.003, *df* = 86), and pasture 3 points (*F* = 6.69, *P* = 0.01, *df* = 87). Mean/point density of pooled upland points was greater than pooled pasture 1 and 2 points (*F* = 14.48, *P* < 0.001, *df* = 103) and pasture 3 points (*F* = 7.90, *P* = 0.01, *df* = 104). Mean/point density of non-mined pasture was greater than mean/point density of wetland pooled points [(*F* = 5.47, *P* = 0.02, *df* = 46); Table 12].

The ground nesting guild had lower mean/point density in non-mined bottomland points than in pasture 1 (*F* = 59.65, *P* < 0.001, *df* = 49), pooled pasture 2 and 3 (*F* = 28.5, *P* < 0.001, *df* = 86), upland 1 (*F* = 44.96, *P* < 0.001, *df* = 43), pooled upland 2 and 3 (*F* = 15.88, *P* < 0.001, *df* = 41), and pooled wetland points (*F* = 17.15, *P* < 0.001, *df* = 49). However mean/point density in non-mined bottomland was greater than in pasture non-mined (*F* = 12.53, *P* < 0.001, *df* = 46). Mean/point density in bottomland 1 points was greater than in non-mined pasture (*F* = 20.67, *P* < 0.001, *df* = 28), non-mined upland (*F* = 67.00, *P* < 0.001, *df* = 31), and pooled upland 2 and 3 points (*F* = 17.72, *P* < 0.001, *df* = 23). Mean/point density in pooled bottomland 2 and 3 points was greater than in non-mined upland points (*F* = 14.06, *P* < 0.001, *df* = 36). However mean/point density in bottomland 2,3 points was less than mean/point density in pasture 1 (*F* = 14.58, *P* <

0.001, *df* = 36), pooled pasture 2 and 3 (*F* = 4.46, *P* = 0.04, *df* = 73), and in upland 1 points [(*F* = 13.57, *P* < 0.001, *df* = 30); Table 12].

In 2004, several significant differences existed in mean/point densities of nesting guilds among vegetation types (Table 13). The aquatic nesting guild had greater mean/point density in wetland 2 points than pooled bottomland points (*F* = 42.09, *P* < 0.001, *df* = 45), pooled pasture (*F* = 105.69, *P* < 0.001, *df* = 110), and in pooled upland points (*F* = 55.49, *P* < 0.001, *df* = 62).

The canopy nesting guild had greater mean/point density in pooled bottomland points than in pooled pasture 1 and 2 (*F* = 45.87, *P* < 0.001, *df* = 86), upland 1 (*F* = 16.00, *P* < 0.001, *df* = 62), and wetland pooled points (*F* = 19.82, *P* < 0.001, *df* = 68). Mean/point density in pooled upland non-mined, 2 and 3 was greater than in pooled pasture 1 and 2 (*F* = 53.73, *P* < 0.001, *df* = 84), and in pooled wetland points [(*F* = 23.74, *P* < 0.001, *df* = 66); Table 13].

The brush nesting guild only had greater mean/point density in pooled bottomland points than in pooled pasture points (*F* = 6.51, *P* = 0.01, *df* =152). The cavity nesting guild mean/point density was higher in pooled bottomland points than in non-mined pasture (*F* = 4.93, *P* = 0.03, *df* = 65), pasture 1 (*F* = 20.97, *P* < 0.001, *df* = 68), pooled pasture 2 and 3 (*F* = 37.83, *P* < 0.001, *df* = 105), upland 1 (*F* = 14.95, *P* < 0.001, *df* = 62), pooled upland 2 and 3 (*F* = 5.26, *P* = 0.03, *df* = 60), and in pooled wetland points (*F* = 9.27, *P* < 0.001, *df* = 68). Mean/point density in non-mined upland points was greater than in pasture non-mined (*F* = 17.03, *P* < 0.001, *df* = 46), pasture 1 (*F* = 54.25, *P* < 0.001, *df* = 49), pooled pasture 2 and 3 points (*F* = 96.75, *P* < 0.001, *df* =

Table 13. Mean nesting guild density (individuals/ha) on non-mined and reclaimed areas by vegetation type at Big Brown Mine, Freestone County, Texas for 2004. Groups that share the same capital letter(s) among the same vegetation groups are not statistically ($P < 0.05$) different.

| Nesting guild | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aquatic[b] | | | Brush | | | Canopy | | | Cavity | | | Colonial | | | Ground | | |
| Veg. type | $\bar{x} \pm SE$ | $n$ | Veg. type | $\bar{x} \pm SE$ | $n$ | Veg. type | $\bar{x} \pm SE$ | $n$ | Veg. type | $\bar{x} \pm SE$ | $n$ | Veg. type | $\bar{x} \pm SE$ | $n$ | Veg. type | $\bar{x} \pm SE$ | $n$ |
| BL | $0.00 \pm 0.00^{A}$ | 44 | BL | $0.36 \pm 0.41^{A}$ | 44 | BL | $0.35 \pm 0.23^{AC}$ | 44 | BL | $0.15 \pm 0.16^{AB}$ | 44 | BL | $0.03 \pm 0.12^{AC}$ | 44 | NMBL23 | $0.08 \pm 0.19^{A}$ | 37 |
| | | | | | | | | | | | | | | | BL1 | $0.36 \pm 0.19^{EFG}$ | 7 |
| UL | $0.00 \pm 0.02^{A}$ | 61 | UL | $0.26 \pm 0.18^{AB}$ | 61 | NMUL23 | $0.36 \pm 0.22^{C}$ | 42 | NMUL | $0.21 \pm 0.14^{B}$ | 25 | UL | $0.03 \pm 0.11^{A}$ | 61 | NMUL23 | $0.12 \pm 0.18^{AD}$ | 42 |
| | | | | | | UL1 | $0.13 \pm 0.10^{DE}$ | 19 | UL1 | $0.00 \pm 0.02^{CG}$ | 19 | | | | UL1 | $0.53 \pm 0.29^{BG}$ | 19 |
| | | | | | | | | | UL23 | $0.06 \pm 0.07^{DE}$ | 17 | | | | | | |
| P | $0.00 \pm 0.01^{A}$ | 109 | P | $0.20 \pm 0.32^{B}$ | 109 | NMP3 | $0.27 \pm 0.34^{ACD}$ | 66 | NMP | $0.07 \pm 0.08^{E}$ | 22 | P | $0.12 \pm 0.28^{B}$ | 109 | NMP | $0.211 \pm 0.26^{DE}$ | 22 |
| | | | | | | P12 | $0.09 \pm 0.11^{BE}$ | 43 | P1 | $0.00 \pm 0.00^{CF}$ | 25 | | | | P123 | $0.47 \pm 0.40^{BCF}$ | 87 |
| | | | | | | | | | P23 | $0.02 \pm 0.04^{G}$ | 62 | | | | | | |
| NMWL13 | $0.00 \pm 0.02^{A}$ | 24 | WL | $0.21 \pm 0.17^{AB}$ | 25 | WL | $0.13 \pm 0.13^{BD}$ | 25 | WL | $0.04 \pm 0.08^{DE}$ | 25 | WL | $0.10 \pm 0.20^{BC}$ | 25 | WL | $0.31 \pm 0.25^{EF}$ | 25 |
| WL2 | $0.55 \pm 0.78^{B}$ | 2 | | | | | | | | | | | | | | | |

[a]BL = bottomland forest, UL = upland forest, P = pasture, WL = wetland, [b]Nesting guilds

86), and pooled wetland points (*F* = 26.03, *P* < 0.001, *df* = 49). Mean/point density of pooled upland 2 and 3 points was greater than pasture 1 points (*F* = 14.91, *P* < 0.001, *df* = 41) and pooled pasture 2 and 3 points (*F* = 8.35, *P* = 0.01, *df* = 78). Mean/point density of non-mined pasture was greater than that of upland 1 points (*F* = 11.11, *P* < 0.001, *df* = 40). Mean/point density of pooled wetland points was greater than that of pasture 1 (*F* = 7.79, *P* = 0.01, *df* = 49), pooled pasture 2 and 3 (*F* = 4.34, *P* = 0.04, *df* = 86), and upland 1 points [(*F* = 4.65, *P* = 0.04, *df* = 43); Table 13].

Mean/point density of the colonial nesting guild was greater in pooled pasture points than in pooled bottomland (*F* = 4.50, *P* = 0.04, *df* = 152), and pooled upland points (*F* = 5.91, *P* = 0.02, *df* = 134). Pooled wetland points had greater mean/point density than that of pooled upland points [(*F* = 4.45, *P* = 0.04, *df* = 85); Table 13].

Mean/point density of the ground nesting guild in pooled bottomland non-mined, 2 and 3 was less than in non-mined pasture (*F* = 5.07, *P* = 0.03, *df* = 58), pooled pasture 1, 2, and 3 (*F* = 31.57, *P* < 0.001, *df* = 123), upland 1 (*F* = 48.53, *P* < 0.001, *df* = 55), and pooled wetland points (*F* = 17.59, *P* < 0.001, *df* = 61). Mean/point density in upland 1 points was greater than in non-mined pasture (*F* = 13.55, *P* < 0.001, *df* = 40), and pooled wetland points (*F* = 6.77, *P* = 0.01, *df* = 43). Mean/point density of pooled upland non-mined, 2, and 3 was less than that of bottomland 1 (*F* = 10.39, *P* < 0.001, *df* = 48), pooled pasture 1, 2, and 3 (*F* = 28.54, *P* < 0.001, *df* = 128), and pooled wetland points [(*F* = 13.33, *P* < 0.001, *df* = 66); Table 13].

**Comparison with Cantle's (1978) Study**

No significant difference was found between Cantle's (1978) bird density data for the first ($\bar{x}$ = 2.56, *SE* = 0.59) and second ($\bar{x}$ = 2.36, *SE* = 0.40) breeding seasons so the data were pooled. There was a significant (*F* = 11.47, *P* = 0.001, *df* = 127) difference between my 0-5 age class mean/point density data for the first ($\bar{x}$ = 1.26, *SE* = 0.09) and second ($\bar{x}$ = 0.92, *SE* = 0.05) breeding seasons and therefore they were not pooled. Cantle's overall mean density ($\bar{x}$ = 2.46, *SE* = 0.33) was higher than the mean/point density of both of my breeding seasons. There was a significant difference between Cantle's overall mean density and my first breeding season (*F* = 19.86, *P* < 0.001, *df* = 71) and second breeding season (*F* = 70.17, *P* < 0.001, *df* = 71; Fig. 16) mean/point densities.

No significant difference in mean species diversity was found between Cantle's (1978) first ($\bar{x}$ = 1.62, *SE* = 0.10) and second ($\bar{x}$ = 1.36, *SE* = 0.15) seasons. There also was no difference between mean/point diversity of my first ($\bar{x}$ = 2.14, *SE* = 0.07) and second ($\bar{x}$ = 1.96, *SE* = 0.08) seasons. Therefore, diversity data from Cantle's two seasons were pooled together, as were mean/point density data from my two seasons. My mean/point diversity ($\bar{x}$ = 2.05, *SE* = 0.05) was higher than that of Cantle's ($\bar{x}$ = 1.49, *SE* = 0.10). A significant (*F* = 6.99, *P* = 0.009, *df* = 135) difference existed between my mean/point diversity and Cantle's diversity (Fig. 17).

No significant difference was found between Cantle's (1978) mean bird richness data for the first ($\bar{x}$ = 5.11, *SE* = 0.0.83) and second ($\bar{x}$ = 4.50, *SE* = 0.23) breeding

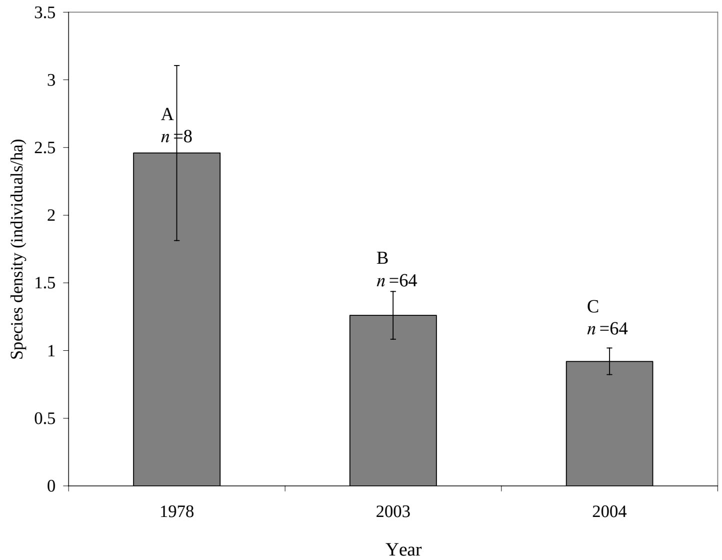



Fig. 16. Differences (error bars represent a 95% confidence interval) in mean species density (individuals/ha) on 0-5 years reclaimed land between 2003, 2004, and Cantle (1978) at Big Brown Mine, Freestone County, Texas. Bars that share the same capital letter(s) among the same vegetation groups are not statistically ($P < 0.05$) different.

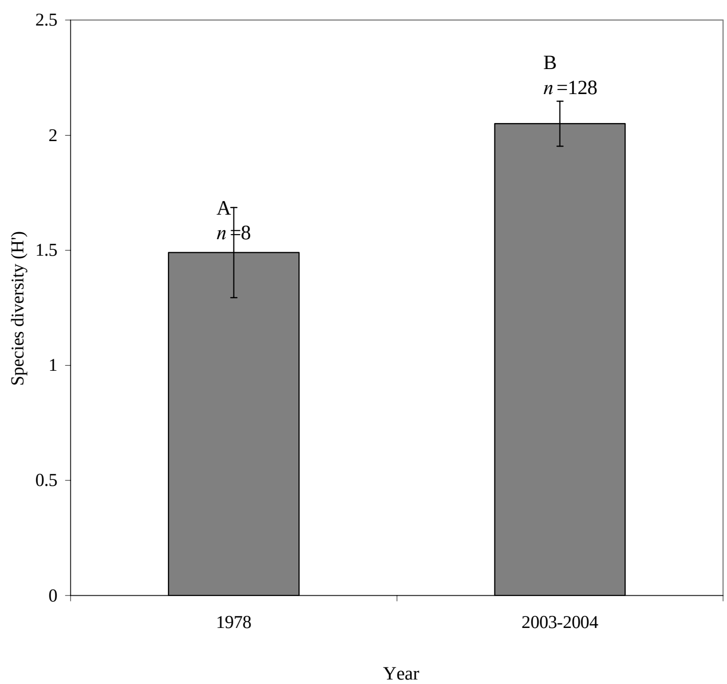



Fig. 17. Differences (error bars represent a 95% confidence interval) in mean species diversity (*H*) on 0-5 years reclaimed land between 2003, 2004, and Cantle (1978) at Big Brown Mine, Freestone County, Texas. Bars that share the same capital letter(s) among the same vegetation groups are not statistically ($P < 0.05$) different.

seasons so the data were pooled. There was a significant (*F* = 4.08, *P* = 0.045, *df* = 127) difference between my 0-5 age class mean/point richness data for the first ($\bar{x}$ = 6.14, *SE* = 0.23) and second ($\bar{x}$ = 5.36, *SE* = 0.31) breeding seasons and therefore they were not pooled. No significant differences in mean/point species richness were found between my first and second season data and Cantle's overall mean richness data ($\bar{x}$ = 4.81, *SE* = 0.41).

Cantle (1978) observed 42 species total during his study. I observed a total of 43 species in 2003, 46 species in 2004 and 60 species over both seasons on my 0-5 years since reclaimed points. Cantle also observed a total of 23 species on his original control transect. Three of my points were near Cantle's original control transect which were all non-mined upland points. I observed a total of 15 species at these three points. Six species were in common with those observed by Cantle. These included Mourning Dove, Yellow-billed Cuckoo, American Crow, Blue Jay, Carolina Chickadee, and Brown-headed Cowbird. Both Cantle and I observed a majority of species in the canopy nesting guild.

Cantle (1978) observed 16 species on his newly reclaimed transect. Two of my points were on this transect and were both in the over 20 years reclaimed pasture category. I observed a total of 11 species at these two points. As with the control transect, 6 species were in common between my points and Cantle's transect. These included Mourning Dove, Eastern Meadowlark, Scissor-tailed Flycatcher, Grasshopper Sparrow, Dickcissel, and Eastern Kingbird. However, a majority of the species on

Cantle's transect were ground nesters, whereas my points had a majority of canopy nesters.

**Local Vegetation Correlations**

Tables 14 and 15 display the mean/point density and standard error for the top 10 species overall, in the reclaimed area, and non-mined area, and species of conservation concern in the herbaceous vegetation for each season. The herbaceous measurements also were correlated to the mean/point density of the top 10 species and species of conservation concern. The correlations match the habitat in which each species is expected to be seen according to their nesting guild. The following are the results for correlations with top 10 list species. Mean/point density of Dickcissels, also a species of conservation concern, was positively correlated with bunchgrass ($r$ = 0.238, $P$ < 0.001), and forbs ($r$ = 0.220, $P$ = 0.001) in 2003, and litter ($r$ = 0.225, $P$ < 0.001), and other grasses ($r$ = 0.133, $P$ = 0.04) in 2004. Mean/point density of Dickcissels was negatively correlated with woody cover in 2003 ($r$ = -0.169, $P$ = 0.009). Mean/point density of Red-winged Blackbirds had only one correlation with visual obstruction in 2003 ($r$ = 0.192, $P$ < 0.001). Mean/point density of Northern Cardinals had a positive correlation with litter ($r$ = 0.204, $P$ = 0.002; $r$ = 0.358, $P$ < 0.001) and woody cover ($r$ = 0.376, $P$ < 0.001; $r$ = 0.204, $P$ = 0.002) in 2003 and 2004. Mean/point density of this species was negatively correlated with other grasses in 2003 and 2004 ($r$ = -0.304, $P$ < 0.001; $r$ = -0.309, $P$ < 0.001). Mean/point density of Eastern Meadowlarks had a positive correlation with other grasses in 2003 and 2004 ($r$ = 0.345, $P$ < 0.001; $r$ = 0.264, $P$ < 0.001). Mean/point density of Eastern Meadowlarks was negatively correlated

Table 14. Mean density and *SE* ($\bar{x}$ , *SE)* for the 10 most numerous species over the entire mine and species of conservation concern per the presence of herbaceous vegetation at Big Brown Mine, Freestone County, Texas, 2003. Values in bold represent significant (*P* < 0.05) positive correlations and values in italics represent significant negative correlations.

| Species[a] | Bare ground[c] | Bunchgrass | Litter | Forbs | Other grass | Woody | Robel height |
|---|---|---|---|---|---|---|---|
| DICK[b] | 0.15 ± 0.03 | **0.25 ± 0.06** | 0.16 ± 0.02 | **0.17 ± 0.02** | 0.16 ± 0.02 | *0.08 ± 0.02* | 0.17 ± 0.02 |
| RWBB | 0.09 ± 0.02 | 0.12 ± 0.04 | 0.06 ± 0.02 | 0.08 ± 0.01 | 0.09 ± 0.02 | 0.05 ± 0.01 | **0.09 ± 0.02** |
| NOCA | 0.09 ± 0.01 | 0.12 ±0.01 | **0.09 ± 0.01** | 0.09 ± 0.01 | *0.08 ± 0.01* | **0.18 ± 0.01** | 0.09 ± 0.01 |
| EAME | 0.06 ± 0.01 | 0.03 ±0.01 | 0.06 ±0.01 | 0.06 ± 0.01 | **0.07 ± 0.01** | *0.02 ± 0.00* | 0.06 ± 0.00 |
| MODO | 0.06 ± 0.02 | **0.10 ±0.04** | 0.06 ± 0.01 | 0.05 ± 0.01 | 0.04 ± 0.00 | 0.05 ± 0.01 | 0.06 ± 0.01 |
| BHCB | 0.06 ± 0.03 | 0.06 ± 0.02 | 0.05 ± 0.02 | 0.06 ± 0.02 | 0.05 ± 0.02 | 0.08 ± 0.05 | 0.05 ± 0.02 |
| CLSW | 0.06 ± 0.04 | 0.02 ± 0.01 | 0.05 ± 0.02 | 0.05 ± 0.03 | 0.06 ± 0.03 | 0.01 ± 0.01 | 0.05 ± 0.02 |
| STFC | 0.04 ± 0.01 | 0.02 ± 0.01 | 0.04 ± 0.00 | 0.04 ± 0.00 | **0.04 ± 0.01** | 0.02 ± 0.01 | 0.04 ± 0.00 |
| GHSP | 0.03 ± 0.01 | 0.01± 0.00 | 0.04 ± 0.00 | 0.04 ± 0.01 | **0.04 ± 0.01** | *0.00 ± 0.00* | 0.04 ± 0.01 |
| CAWR | 0.03 ± 0.00 | 0.05 ± 0.01 | **0.04 ±0.00** | 0.04 ± 0.00 | *0.03 ± 0.00* | **0.07 ± 0.01** | 0.04 ± 0.00 |
| TUTI | 0.02 ± 0.01 | 0.03 ± 0.01 | 0.03 ± 0.00 | *0.02 ± 0.00* | *0.02 ± 0.00* | **0.05 ± 0.01** | 0.02 ± 0.00 |
| WEVI | 0.02 ± 0.00 | 0.02 ± 0.01 | 0.03 ± 0.00 | 0.02 ± 0.00 | *0.02 ± 0.00* | **0.06 ± 0.01** | 0.02 ± 0.00 |
| CEWA | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| BLJA | 0.01 ± 0.00 | 0.00 ± 0.00 | 0.01 ± 0.00 | 0.01 ± 0.00 | 0.01 ± 0.00 | **0.03 ± 0.01** | 0.01 ± 0.00 |
| CACH | 0.03 ± 0.01 | 0.03 ± 0.01 | 0.03 ± 0.00 | 0.03 ± 0.00 | *0.02 ± 0.00* | 0.05 ± 0.01 | 0.03 ± 0.00 |
| EUST | **0.09 ± 0.07** | 0.00 ± 0.00 | *0.05 ± 0.04* | 0.02 ± 0.02 | **0.06 ± 0.04** | 0.00, 0.00 | 0.06 ± 0.04 |
| PABU[b] | 0.03 ± 0.00 | 0.04 ± 0.01 | 0.03 ± 0.00 | 0.03 ± 0.00 | *0.03 ± 0.00* | **0.05 ± 0.01** | 0.03 ± 0.00 |
| AMRS[b] | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| WOST[b] | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| BEVI[b] | 0.01 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | **0.01 ± 0.00** | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.01 ± 0.00 |

[a]Species abbreviations found in Appendix A, [b]Species of conservation concern, [c]Sample size is the same for each species; n = 103 for "Bare ground", 55 for "Bunchgrass", 240 for "Litter", 192 for "Forbs", 198 for "Other grass", 83 for "Woody", and 215 for "Robel height"

Table 15. Mean density and *SE* ($\bar{x}$ *, SE)* for the 10 most numerous species over the entire mine and species of conservation concern per the presence of herbaceous vegetation at Big Brown Mine, Freestone County, Texas 2004. Values in bold represent significant (*P* < 0.05) positive correlations and values in italics represent significant negative correlations.

| Species[a] | Bare ground[c] | Bunchgrass | Litter | Forbs | Other grass | Woody | Robel height |
|---|---|---|---|---|---|---|---|
| DICK[b] | 0.18 ± 0.03 | 0.24 ± 0.04 | **0.18 ± 0.02** | 0.19 ± 0.02 | **0.19 ± 0.02** | 0.11 ± 0.03 | 0.21 ± 0.02 |
| RWBB | 0.12 ± 0.03 | 0.08 ± 0.02 | 0.11 ± 0.02 | 0.11 ± 0.02 | 0.12 ± 0.02 | 0.02 ± 0.01 | 0.12 ± 0.02 |
| NOCA | 0.08 ± 0.01 | 0.07 ± 0.01 | **0.08 ± 0.01** | 0.07 ± 0.01 | *0.07 ± 0.01* | **0.12 ± 0.01** | 0.06 ± 0.01 |
| EAME | 0.04 ± 0.01 | 0.03 ± 0.01 | *0.04 ± 0.00* | 0.04 ± 0.01 | **0.05 ± 0.01** | *0.01 ± 0.00* | 0.05 ± 0.01 |
| MODO | **0.04 ± 0.01** | 0.04 ± 0.01 | 0.04 ± 0.00 | 0.03 ± 0.00 | 0.03 ± 0.01 | 0.03 ± 0.01 | 0.03 ± 0.00 |
| BHCB | 0.03 ± 0.01 | 0.04 ± 0.01 | 0.03 ± 0.00 | 0.03 ± 0.00 | 0.03 ± 0.00 | 0.06 ± 0.01 | 0.03 ± 0.01 |
| CLSW | 0.01 ± 0.00 | 0.00 ± 0.00 | 0.03 ± 0.01 | **0.03 ± 0.01** | 0.03 ± 0.01 | 0.02 ± 0.02 | 0.03, 0.01 |
| STFC | 0.03 ± 0.01 | 0.02 ± 0.01 | *0.0 3 ± 0.00* | 0.03 ± 0.00 | **0.04 ± 0.00** | 0.01 ± 0.01 | 0.04 ± 0.00 |
| GHSP | 0.04 ± 0.01 | 0.01 ± 0.01 | *0.03 ± 0.00* | 0.03 ± 0.00 | **0.04 ± 0.01** | *0.00 ± 0.00* | 0.04 ± 0.01 |
| CAWR | 0.03 ± 0.00 | 0.02 ± 0.01 | **0.03 ± 0.00** | 0.03 ± 0.00 | *0.03 ± 0.00* | **0.06 ± 0.01** | 0.02 ± 0.00 |
| TUTI | 0.03 ± 0.00 | 0.01 ± 0.01 | **0.02 ± 0.00** | 0.02 ± 0.00 | *0.02 ± 0.00* | **0.05 ± 0.01** | *0.02 ± 0.00* |
| WEVI | 0.02 ± 0.00 | 0.02 ± 0.01 | **0.02 ± 0.00** | 0.02 ± 0.00 | *0.02 ± 0.00* | **0.05 ± 0.01** | 0.02 ± 0.00 |
| CEWA | 0.03 ± 0.03 | 0.00 ± 0.00 | 0.01 ± 0.01 | 0.02 ± 0.02 | 0.03 ± 0.02 | **0.09 ± 0.09** | 0.00 ± 0.00 |
| BLJA | 0.02 ± 0.01 | 0.02 ± 0.01 | **0.02 ± 0.00** | 0.02 ± 0.00 | *0.02 ± 0.00* | **0.04 ± 0.01** | 0.02 ± 0.00 |
| CACH | 0.03 ± 0.00 | 0.03 ± 0.01 | **0.03 ± 0.00** | 0.02 ± 0.00 | *0.02 ± 0.00* | 0.05 ± 0.01 | 0.02 ± 0.00 |
| EUST | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| PABU[b] | 0.03 ± 0.00 | 0.05 ± 0.01 | 0.03 ± 0.00 | 0.03 ± 0.00 | 0.03 ± 0.00 | 0.04 ± 0.01 | 0.03 ± 0.00 |
| AMRS[b] | 0.00 ± 0.00 | 0.00 ± 0.00 | **0.00 ±0.00** | 0.00 ±0.00 | 0.00 ±0.00 | 0.00 ±0.00 | 0.00 ±0.00 |
| WOST[b] | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| BEVI[b] | 0.00 ± 0.00 | 0.01 ± 0.01 | 0.00 ± 0.00 | *0.00 ± 0.00* | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |

[a]Species abbreviations found in Appendix A, [b]Species of conservation concern, [c]Sample size is the same for each species; n = 123 for "Bare ground", 47 for "Bunchgrass", 222 for "Litter", 185 for "Forbs", 205 for "Other grass", 45 for "Woody", and 193 for "Robel height"

with woody cover in 2003 and 2004 (*r* = -0.280, *P* < 0.001; *r* = -0.14, *P* = 0.031) and litter in 2004 (*r* = -0.302, *P* < 0.001). Mean/point density of Mourning Doves had a positive correlation with bunchgrass in 2003 (*r* = 0.273, *P* < 0.001) and bare ground in 2004 (*r* = 0.182, *P* = 0.005). Mean/point density of Brown-headed Cowbirds had no correlations with herbaceous vegetation. Mean/point density of Cliff Swallows had one correlation with forbs in 2004 (*r* = 0.153 *P* = 0.018). Mean/point density of Scissor-tailed Flycatchers had a positive correlation with other grasses in 2003 and 2004 (*r* = 0.259, *P* < 0.001; *r* = 0.171, *P* = 0.008). Mean/point density of this species had a negative correlation with litter in 2004 (*r* = -0.171, *P* = 0.008). Mean/point density of Grasshopper Sparrows had a positive correlation with other grasses in 2003 and 2004 (*r* = 0.289, *P* < 0.001; *r* = 0.319, *P* < 0.001), and negative correlations with woody cover in 2003 and 2004 (*r* = -0.207, *P* = 0.001; *r* = -0.137, *P* =0.034) and litter in 2004 (*r* = -0.282, *P* < 0.001). Mean/point density of Carolina Wrens had positive correlations with litter (*r* =0.168, *P* = 0.009; *r* = 0.334, *P* < 0.001) and woody cover (*r* = 0.375, *P* = 0; *r* = 0.254, *P* < 0.001) in 2003 and 2004. Mean/point density of this species had a negative correlation with other grasses in 2003 and 2004 (*r* = -0.323, *P* < 0.001; *r* = -0.289, *P* < 0.001). Mean/point density of the Tufted Titmouse had positive correlations with woody cover in 2003 and 2004 (*r* = 0.202, *P* = 0.002; *r* = 0.169, *P* = 0.009) and litter in 2004 (*r* = 0.266, *P* < 0.001). Mean/point density of this species had negative correlations with forbs in 2003 (r = -0.182, *P* = 0.005), other grasses in 2003 and 2004 (*r* = -0.212, *P* = 0.001; *r* = -0.210, *P* = 0.001) and visual obstruction in 2004 (*r* = -0.132, *P* = 0.041). Mean/point density of White-eyed Vireos had positive correlations with woody cover in

2003 and 2004 ($r = 0.405$, $P < 0.001$; $r = 0.209$, $P = 0.001$) and litter in 2004 ($r = 0.318$, $P < 0.001$). Mean/point density of White-eyed Vireos had a negative correlation with other grasses in 2003 and 2004 ($r = -0.259$, $P < 0.001$; $r = -0.256$, $P < 0.001$). Mean/point density of Cedar Waxwings had one correlation with woody cover in 2004 ($r = 0.490$, $P < 0.001$). Mean/point density of Blue Jays had positive correlations with woody cover in 2003 and 2004 ($r = 0.171$, $P = 0.008$; $r = 0.143$, $P = 0.028$) and litter in 2004 ($r = 0.192$, $P = 0.003$). Mean/point density of this species had a negative correlation with other grasses in 2004 ($r = -0.188$, $P = 0.004$). Mean density of Carolina Chickadees had a positive correlation with litter in 2004 ($r = 0.334$, $P < 0.001$) and a negative correlation with other grasses in 2003 and 2004 ($r = -0.164$, $P = 0.011$; $r = -0.196$, $P = 0.002$). Mean/point density of European Starlings had positive correlations with bare ground ($r = 0.209$, $P = 0.001$) and other grasses ($r = 0.141$, $P = 0.029$) in 2003. Mean/point density of this species had a negative correlation with litter in 2003 ($r = -0.131$, $P = 0.043$). Mean/point density of Painted Buntings, also a species of conservation concern, had a positive correlation with woody cover in 2003 ($r = 0.164$, $P = 0.011$) and a negative correlation with other grasses in 2003 ($r = -0.227$, $P < 0.001$). Mean/point density of American Redstarts, a species of conservation concern, had one correlation with litter in 2004 ($r = 0.130$, $P = 0.045$). Mean density of Wood Storks, another species of conservation concern, had no correlations. Finally, Mean/point density of Bell's Vireos, a species of conservation concern, had a positive correlation with forbs in 2003 ($r = 0.231$, $P < 0.001$) and a negative correlation with other grasses in 2003 ($r = -0.128$, $P = 0.049$).

Table 16 displays the mean/point density and standard error of the most numerous species and species of concern in woody vegetation. The species' mean/point density was correlated to woody vegetation measurements taken in 2004. Again, the correlations generally match what is expected of each species. The following are the results for mean/point density correlations with top 10 list species. Mean/point density of Red-winged Blackbirds, Mourning Doves, Cliff Swallows, European Starlings, Painted Buntings, and Wood Storks had no woody vegetation correlations. The Painted Bunting and Wood Stork are species of conservation concern. Mean/point density of Dickcissels, also a species of conservation concern, was positively correlated with percent pine cover ($r = 0.169$, $P = 0.009$) and negatively correlated with percent tree canopy cover ($r = -0.261$, $P < 0.001$), number of trees ($r = -0.24$, $P < 0.001$), tree species richness ($r = -0.263$, $P < 0.001$), average tree height ($r = -0.176$, $P < 0.001$), and percent yaupon cover ($r = -0.218$, $P = 0.001$). Mean/point density of Northern Cardinals had positive correlations with percent tree canopy cover ($r = 0.437$, $P < 0.001$), number of trees ($r = 0.388$, $P < 0.001$), tree height ($r = 0.426$, $P < 0.001$), percent yaupon ($r = 0.266$, $P < 0.001$), and percent willow bacharris ($r = 0.137$, $P = 0.034$). No negative correlations with mean/point density of this species existed. Mean density of Eastern Meadowlarks had only negative correlations which consisted of percent tree canopy cover ($r = -0.227$, $P < 0.001$), number of trees ($r = -0.236$, $P < 0.001$), tree species richness ($r = -0.276$, $P < 0.001$), average tree height ($r = -0.215$, $P = 0.001$), and percent yaupon ($r = -0.133$, $P = 0.010$). Mean/point density of Brown-headed Cowbirds had positive correlations of mean/point density with percent tree canopy cover ($r = 0.164$, $P = 0.011$), number of

Table 16. Mean density and *SE* ($\bar{x}$ , *SE)* for the 10 most numerous species over the entire mine and species of conservation concern per the presence of woody vegetation at Big Brown Mine, Freestone County, Texas 2004. Values in bold represent significant ($P < 0.05$) positive correlations and values in italics represent significant negative correlations.

| Species[a] | % Canopy[c] cover | Number of trees | Tree species richness | Average tree height | % Pine | % Yaupon | % Willow bacharris |
|---|---|---|---|---|---|---|---|
| DICK[b] | *0.12 ± 0.02* | *0.13 ± 0.02* | *0.13 ± 0.02* | *0.13 ± 0.02* | **0.38 ± 0.08** | *0.01 ± 0.01* | 0.27 ± 0.05 |
| RWBB | 0.10 ± 0.03 | 0.10 ± 0.03 | 0.10 ± 0.03 | 0.10 ± 0.03 | 0.14 ± 0.03 | 0.12 ± 0.07 | 0.16 ± 0.05 |
| NOCA | **0.13 ± 0.01** | **0.12 ± 0.01** | **0.12 ± 0.01** | **0.12 ± 0.01** | 0.01 ± 0.01 | **0.14 ± 0.01** | **0.06 ± 0.01** |
| EAME | *0.01 ± 0.00* | *0.01 ± 0.00* | *0.01 ± 0.00* | *0.01 ± 0.00* | 0.03 ± 0.01 | *0.00 ± 0.00* | 0.02 ± 0.01 |
| MODO | 0.04 ± 0.00 | 0.04 ± 0.01 | 0.04 ± 0.00 | 0.04 ± 0.01 | 0.06 ± 0.02 | 0.03 ± 0.01 | 0.04 ± 0.01 |
| BHCB | **0.05 ± 0.01** | **0.05 ± 0.01** | 0.05 ± 0.01 | **0.05 ± 0.01** | 0.06 ± 0.01 | 0.04 ± 0.01 | 0.05 ± 0.01 |
| CLSW | 0.02 ± 0.01 | 0.02 ± 0.01 | 0.02 ± 0.01 | 0.02 ± 0.01 | 0.01 ± 0.01 | 0.00 ± 0.00 | 0.05 ± 0.04 |
| STFC | *0.02 ± 0.00* | *0.02 ± 0.00* | *0.02 ± 0.00* | *0.02 ± 0.00* | 0.03 ± 0.01 | *0.00 ± 0.00* | 0.02 ± 0.01 |
| GHSP | *0.00 ± 0.00* | *0.00 ± 0.00* | *0.00 ± 0.00* | *0.00 ± 0.00* | 0.00 ± 0.00 | *0.00 ± 0.00* | 0.00 ± 0.00 |
| CAWR | **0.05 ± 0.01** | **0.05 ± 0.01** | **0.05 ± 0.01** | **0.05 ± 0.01** | 0.00 ± 0.00 | **0.08 ± 0.01** | 0.02 ± 0.01 |
| TUTI | **0.04 ± 0.01** | **0.04 ± 0.01** | **0.04 ± 0.01** | **0.04 ± 0.01** | 0.00 ± 0.00 | **0.09 ± 0.02** | 0.00 ± 0.00 |
| WEVI | **0.04 ± 0.01** | **0.04 ± 0.00** | **0.04 ± 0.01** | **0.04 ± 0.01** | 0.00 ± 0.00 | **0.07 ± 0.01** | **0.02 ± 0.01** |
| CEWA | **0.05 ± 0.04** | **0.04 ± 0.04** | **0.04 ± 0.04** | 0.04 ± 0.04 | 0.00 ± 0.00 | **0.14 ± 0.11** | 0.00 ± 0.00 |
| BLJA | **0.04 ± 0.01** | **0.04 ± 0.01** | **0.04 ± 0.01** | **0.04 ± 0.01** | 0.00 ± 0.00 | **0.08 ± 0.02** | 0.01 ± 0.01 |
| CACH | **0.04 ± 0.01** | **0.04 ± 0.01** | **0.04 ± 0.01** | **0.04 ± 0.01** | 0.02 ± 0.02 | **0.05 ± 0.01** | 0.01 ± 0.01 |
| EUST | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| PABU[b] | 0.04 ± 0.01 | 0.04 ± 0.01 | 0.04 ± 0.00 | 0.04 ± 0.01 | 0.06 ± 0.01 | 0.02 ± 0.01 | 0.05 ± 0.01 |
| AMRS[b] | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | **0.00 ± 0.00** | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| WOST[b] | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| BEVI[b] | 0.01 ± 0.00 | 0.00 ± 0.00 | 0.01 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | **0.02 ± 0.01** |

[a]Species abbreviations found in Appendix A, [b]Species of conservation concern, [c]Sample size is the same for each species; n = 101 for “% Canopy cover”, 108 for “Number of trees”, 109 for “Tree species richness”, 109 for “Average tree height”, 16 for “% Pine”, 36 for “% Yaupon”, and 31 for “% Willow bacharris”

trees ($r = 0.150$, $P = 0.021$), and average tree height ($r = 0.215$, $P = 0.001$). Mean/point density of Scissor-tailed Flycatchers had only negative correlations of mean/point density with the following measurements: tree canopy cover ($r = -0.224$, $P < 0.001$), number of trees ($r = -0.217$, $P = 0.001$), tree richness ($r = -0.233$, $P < 0.001$), average tree height ($r = -0.163$, $P = 0.012$), and percent yaupon ($r = -0.144$, $P = 0.026$). Mean density of Grasshopper Sparrows also had only negative correlations of mean/point density with percent tree canopy cover ($r = -0.261$, $P < 0.001$), 0.247, $P < 0.001$), tree species richness ($r = -0.294$, $P < 0.001$), average tree height ($r = -0.289$, $P = 0.001$), and percent yaupon ($r = -0.154$, $P = 0.017$). Mean/point density of Carolina Wrens had only positive correlations with percent tree canopy cover ($r = 0.465$, $P < 0.001$), number of trees ($r = 0.485$, $P < 0.001$), tree species richness ($r = 0.498$, $P < 0.001$), average tree height ($r = 0.342$, $P < 0.001$), and percent yaupon ($r = 0.374$, $P < 0.001$). Mean/point density of the Tufted Titmouse also had only positive correlations of mean/point density with percent tree canopy cover ($r = 0.470$, $P < 0.001$), number of trees ($r = 0.416$, $P < 0.001$), tree species richness ($r = 0.464$, $P < 0.001$). Mean/point density of White-eyed Vireos had only positive correlations with percent tree canopy cover ($r = 0.433$, $P < 0.001$), number of trees ($r = 0.509$, $P < 0.001$), tree species richness ($r = 0.508$, $P < 0.001$), average tree height ($r = 0.322$, $P < 0.001$), percent yaupon ($r = 0.444$, $P < 0.001$), and percent willow bacharris ($r = 0.147$, $P = 0.023$). Mean/point density of Cedar Waxwings had only positive correlations with percent tree canopy cover ($r = 0.179$, $P = 0.005$), number of trees ($r = 0.340$, $P < 0.001$), tree species richness ($r = 0.237$, $P < 0.001$), and percent yaupon ($r = 0.444$, $P < 0.001$). Mean/point density of Blue Jays had only positive correlations with percent tree canopy cover (*r* = 0.347, *P* < 0.001), number of trees (*r* = 0.310, *P* < 0.001), tree species richness (*r* = 0.361, *P* < 0.001), average tree height (*r* = 0.190, *P* = 0.003), and percent yaupon (*r* = 0.367, *P* < 0.001). Mean/point density of Carolina Chickadees had the following positive correlations: percent tree canopy cover (*r* = 0.345, *P* < 0.001), number of trees (*r* = 0.246, *P* < 0.001), tree species richness (*r* = 0.326, *P* < 0.001), average tree height (*r* = 0.324, *P* < 0.001), and percent yaupon (*r* = 0.197, *P* = 0.002). Mean/point density of American Redstarts, a species of concern, had a positive correlation with average tree height (*r* = 0.201, *P* = 0.002). Finally, mean/point density of Bell's Vireos, another species of concern had a positive correlation with percent willow bacharris (*r* = 0.167, *P* = 0.010).

**Landscape Vegetation Correlations**

*Density.*—In comparing mean/point bird density at survey points to the vegetation types around points at a landscape scale (as determined by aerial photos and GIS), no significant correlations were found in 2003. However in 2004, a significant (*r* = 0.180, *P* = 0.005) positive correlation was found between the percent non-mined forest and mean/point density.

*Diversity*.—Mean/point bird diversity at survey points had several significant correlations with the vegetation around points in both 2003 and 2004. The number of vegetation types (*r* = 0.245, *P* < 0.001), number of vegetation-type patches (*r* = 0.300, *P* < 0.001), percent non-mined forest (*r* = 0.401, *P* < 0.001), and percent non-mined pasture (*r* = 0.226, *P* < 0.001) all had significant positive correlations with mean/point bird diversity at survey points in 2003. The percent reclaimed forest (*r* = -0.144, *P* =

0.026) and percent reclaimed pasture ($r = -0.343$, $P < 0.001$) both had negative correlations with mean/point bird diversity in 2003.

As in 2003, number of vegetation types ($r = 0.291$, $P < 0.001$), number of vegetation-type patches ($r = 0.349$, $P < 0.001$), percent non-mined forest ($r = 0.278$, $P < 0.001$), and percent non-mined pasture ($r = 0.155$, $P = 0.016$) had positive correlations with mean/point bird diversity at survey points in 2004. The percent reclaimed pasture had a negative correlation ($r = -0.313$, $P < 0.001$) with mean/point bird diversity at survey points in 2004 as well.

*Richness*.—Mean/point bird richness at survey points had similar correlations to mean/point bird diversity at survey points. In 2003, mean/point bird richness at survey points was positively correlated to number of vegetation types ($r = 0.225$, $P < 0.001$), number of vegetation patches ($r = 0.346$, $P < 0.001$), percent non-mined forest ($r = 0.421$, $P < 0.001$), and percent non-mined pasture ($r = 0.212$, $P = 0.001$). Mean/point bird richness at survey points was negatively correlated to percent reclaimed pasture ($r = -0.346$, $P < 0.001$) in 2003.

In 2004, number of vegetation types ($r = 0.353$, $P = 0.001$), number of vegetation patches ($r = 0.377$, $P < 0.001$), percent non-mined forest ($r = 0.324$, $P$ <0 .001), and percent non-mined pasture ($r = 0.171$, $P = 0.008$) were all positively correlated with mean/point bird richness at survey points. Percent reclaimed pasture ($r = -0.360$, $P < 0.001$) was negatively correlated with mean/point bird richness at survey points.

*Nesting guild density.*—During 2003, no significant differences were found within the aquatic and cavity mean/point nesting guild densities among the vegetation types. However, mean/point density of the brush nesting guild had a significantly positive correlation with number of vegetation types ($r$ = 0.175, $P$ = 0.007), number of vegetation patches ($r$ = 0.167, $P$ = 0.010), percent non-mined forest ($r$ = 0.178, $P$ = 0.006), and percent reclaimed forest ($r$ = 0.132, $P$ = 0.042). Mean/point density of this guild had a significant negative correlation with percent reclaimed pasture ($r$ = -0.243, $P$ < 0.001). Mean/point density of the canopy nesting guild was significantly positively correlated with number of vegetation patches ($r$ = 0.375, $P$ < 0.001), percent non-mined forest ($r$ = 0.301, $P$ < 0.001), and percent non-mined pasture ($r$ = 0.242, $P$ < 0.001). Mean/point density of this guild was negatively correlated with percent reclaimed pasture ($r$ = -0.296, $P$ < 0.001). Mean/point density of the colonial nesting guild was significantly positively correlated with percent reclaimed pasture ($r$ = 0.142, $P$ = 0.028), and negatively correlated with number of vegetation patches ($r$ = -0.144, $P$ = 0.025). Finally, mean/point density of the ground nesting guild was positively correlated with percent reclaimed forest ($r$ = 0.241, $P$ < 0.001), and percent reclaimed pasture ($r$ = 0.293, $P$ < 0.001). Mean/point density of the ground nesting guild was significantly negatively correlated with number of vegetation types ($r$ = -0.215, $P$ = 0.001), number of vegetation patches ($r$ = -0.294, $P$ < 0.001), percent non-mined forest ($r$ = -0.392, $P$ < 0.001), percent non-mined pasture ($r$ = -0.258, $P$ < 0.001), and distance to the nearest pond ($r$ = -0.155, $P$ = 0.017).

In 2004, mean/point density of the aquatic nesting guild was again not significantly correlated with any category. Mean/point density of the brush nesting guild was significantly positively correlated with the number of vegetation types ($r$ = 0.160, $P$

= 0.013), percent non-mined forest (*r* = 0.133, *P* = 0.040) and negatively correlated with percent reclaimed pasture (*r* = -0.196, *P* = 0.002). The mean/point density of the canopy nesting guild was significantly positively correlated with number of vegetation types (*r* = 0.301, *P* < 0.001), number of vegetation patches (*r* = 0.304, *P* < 0.001), percent non-mined forest (*r* = 0.354, *P* < 0.001), and percent non-mined pasture (*r* = 0.166, *P* = 0.010). Mean/point density of this guild was negatively correlated with percent reclaimed pasture (*r* = -0.312, *P* < 0.001). Mean/point density of the cavity nesting guild was significantly positively correlated with number of vegetation types (*r* = 0.342, *P* < 0.001), number of vegetation patches (*r* = 0.407, *P* < 0.001), and percent non-mined forest (*r* = 0.517, *P* < 0.001), and negatively correlated with percent reclaimed pasture (*r* = -0.371, *P* < 0.001). Mean/point density of the colonial nesting guild was positively correlated with percent reclaimed pasture (*r* = 0.196, *P* = 0.002), and negatively correlated to the percent non-mined forest (*r* = -0.178, *P* = 0.006), and distance to the nearest pond (*r* = -0.133, *P* = 0.040). Mean/point density of the ground nesting guild was positively correlated with percent reclaimed pasture (*r* = 0.350, *P* < 0.001), and negatively correlated with number of vegetation types (*r* = -0.290, *P* < 0.001), number of vegetation patches (*r* = -0.355, *P* < 0.001), percent non-mined forest (*r* = -0.392, *P* < 0.001), percent non-mined pasture (*r* = -0.140, *P* = 0.031), and percent pond (*r* = -0.138, *P* = 0.033).

# DISCUSSION

## Density, Diversity, and Richness

Overall density on the non-mined versus the reclaimed area did not have a clear relationship. The overall density was greater over both seasons combined and in 2004 in the non-mined area, but it was greater in the reclaimed area in 2003.

Mean/point density of the entire non-mined area versus the reclaimed area also did not have a clear relationship. Mean/point density was only significantly greater in the non-mined area in 2004. However in 2003 and both seasons combined, no significant difference in mean/point density existed. Therefore, it seems that density is not consistently variable between reclaimed and non-mined lands.

The overall Shannon diversity index ($H$) was greater in the non-mined area for 2003, 2004, and both years combined. Mean/point diversity was significantly greater in the non-mined lands than the reclaimed lands for 2003, 2004, and both years combined.

Overall richness, or number of species counted in each area, was greater in the reclaimed areas than the non-mined areas for 2003, 2004, and both years combined. However, mean/point richness, or number of species counted per point, was significantly greater in the non-mined areas than the reclaimed areas for each season and both seasons combined. This suggests that although the mean/point species richness variability was greater on reclaimed lands as a whole, the average number of different species observed at each point was greater in the non-mined lands. The overall richness results are more meaningful than the mean/point richness results, as the mean/point richness can be skewed by low numbers of species at a few points, while the rest of the points had fairly high species richness. This is especially true in the reclaimed area since several of the newly reclaimed points had little vegetation established and did not attract many species. On the whole, however, the several stages of vegetative succession in the reclaimed area attracted several different species, which is reflected in the overall richness numbers. Age classes ranged from early seral stages to almost climax vegetation in the reclaimed areas. With each different successional stage, different types of species were attracted. For example, grassland species were attracted to the early successional stage lands because of the open, grassy areas created with early reclamation. The older reclamation areas, with more woody cover, attracted canopy and cavity nesting species. Such variation in age of land and successional stage increases the richness of the reclaimed area versus the non-mined area, which consisted of only mature vegetative states. Brenner and Kelly (1981), working on a 20-year-old reclamation site, also found avian species to change as the vegetation successional stage changed, therefore increasing species richness on the overall area. Krementz and Saur (1982) found the richness to be higher in non-mined areas, but were working on three-year-old reclamation sites. Such young sites have few successional stages and therefore few bird species. It seems that as some reclamation sites age and the overall area gains more successional stages, species richness increases.

One potentially contradictive result to be addressed in my study is the higher overall species diversity in non-mined lands than reclaimed lands versus the higher overall species richness in reclaimed lands than non-mined lands. Diversity takes the abundance of each species seen into account, while richness does not. The higher overall diversity, but lower overall richness in non-mined lands suggests that although more species were seen in reclaimed lands than non-mined overall, relatively more individuals of each species were seen in the non-mined lands. The overall mean results show both the mean/point diversity and richness to be greater in non-mined lands.

**Age Class and Vegetation Type Comparisons**

*Density, diversity, and richness.*—Mean/point bird density was higher in reclaimed lands in only one vegetation type in 2003, but not in any vegetation types in 2004. Reclaimed lands had lower mean/point bird diversity and mean richness per point in several vegetation types than non-mined lands. Mean/point bird diversity and richness at points in different aged reclaimed lands generally corresponded to the overall mean diversity and richness numbers (non-mined areas greater mean diversity and richness than reclaimed). One interesting occurrence, however, was the greater mean/point bird diversity in the category 1 age group when compared to the category 3 in both the pasture and upland vegetation types in 2004. It seems that although the category 3 areas are older than 20 years, they have still not reached the maturity of the non-mined lands which many bird species require. The early successional stage of the category 1 lands, however, attracts a higher mean/point diversity of species dependent on disturbance for breeding habitat than does a later successional stage. However, the opposite was true in the richness comparisons. The category 3 lands were greater in mean/point richness per point than the category 1. This is because diversity takes into account relative abundance of a species, whereas richness is just a count of the species present (Stirling and Wilsey 2001). This would indicate that although the category 3 land has more species than the category 1, several of those species are in low numbers. Fritcher et al. (2004) also found bird diversity to be higher in early seral stage grasslands when compared to late and intermediate seral stages. Species richness did not differ among seral stages in their study, however. Rumble and Gobeille (2003) found bird diversity and richness to be higher in late and late-intermediate seral stages than in early seral stages in riparian woodlands dominated by cottonwood (*Populus deltoides*). Although this seems to contradict my data, the difference in vegetation types must be taken into account. The significant differences in mean/point richness and diversity I found between reclaimed-age classes were in the pasture, upland, and wetland vegetation types. The difference in mean/point bird richness and diversity in bottomland areas only differed when comparing non-mined to reclaimed. Therefore, my study does not contradict the Rumble and Gobeille (2003) study as their observations occurred in bottomland areas. My data actually concurs with theirs because the non-mined bottomland areas in my study were a late seral stage and had the highest mean/point diversity.

No definitive conclusions could be drawn from the vegetation type comparisons for mean/point diversity and richness. However, the bottomland vegetation type was greater in mean/point bird diversity for both breeding seasons.

*Nesting guild density.*—Mean/point densities of many of the nesting guild types had several significant relationships with different land age classes. The brush nesting guild had a higher mean/point density per point in non-mined upland and wetland points than reclaimed points in 2003. This is expected as the non-mined areas contain more mature woodland areas with thick underbrush used by these species.

The canopy nesting and cavity nesting guilds had higher mean/point densities in the older reclaimed and in non-mined lands in 2003 and 2004. Canopy nesting birds need trees that are fairly tall and mature and woodlands with a good canopy cover. Cavity nesting birds prefer older trees with large trunks for making cavities. They also prefer standing snags for nesting which generally occur in older woodlands. Therefore both guilds need late successional stage woodlands for nesting, as is demonstrated in the mean/point density results (Thayer Birding Software 1998).

The ground nesting guild had higher mean/point densities in the early successional stage lands, such as those in category 1 and 2 in 2003 and 2004. Species in this guild prefer nesting in open areas with little woody cover. Early successional stage lands generally have little woody species cover, containing no woody species at all, or very young trees and shrubs which do not yet have a canopy cover. Such areas are ideal for ground nesting birds (Thayer Birding Software 1998).

When comparing guild mean/point density among different vegetation types, several significant differences emerged. The aquatic nesting guild had higher mean/point densities in wetland areas than other vegetation types in both 2003 and 2004. Such a result is expected since this guild consists mainly of waterfowl. Most waterfowl need standing water in fairly open areas for nesting. These species prefer ponds with herbaceous vegetation cover such as those in flooded meadows and mashes (Thayer Birding Software 1998).

The brush, canopy, and cavity nesting guilds all generally had higher mean/point densities in the upland and bottomland vegetation types than the pasture and wetland types in 2003 and 2004. All of these nesting guilds need fairly high woody cover with a mature canopy and understory for nesting and feeding (Thayer Birding Software 1998). The pasture and wetland vegetation types had less than 40% woody cover and therefore were not conducive to nesting for any of these guilds. The upland and bottomland forest had higher than 40% woody cover and generally high canopy cover and therefore attracted the species in each of the guilds, as is shown in the mean/point density comparison results.

In 2004, the colonial nesting guild mean/point density was greater in the pasture and wetland vegetation types than the bottomland and upland vegetation types. The colonial nesting guild was comprised mainly of herons, egrets, and swallows. Several of these birds were seen in wetlands and pasture vegetation types near stock ponds. The bottomland and upland areas were most likely too wooded for these species. The Cattle Egret, for example, is known to nest and forage in open pastures and around stock ponds. The Cliff Swallow also forages over open areas and open water. This species also collects mud for its nest from ponds and drainage areas (Thayer Birding Software 1998).

The ground nesting guild was found to have greater mean/point density in the pasture and wetland vegetation types than the bottomland and upland vegetation types in 2003 and 2004. Most ground nesting birds observed in this study are actually grassland dependent birds and prefer large expanses of open areas instead of the thick woody vegetation as found in the bottomland and upland vegetation types. Dickcissels, Eastern Meadowlarks, and Grasshopper Sparrows, for example, nest and forage in weedy fields, meadows, pastures, and cultivated fields, much like the dominant Bermudagrass pastures on the reclaimed areas of the mine (Thayer Birding Software 1998). These three species consisted of the majority of the ground nesting guild. These species have been known to increase in abundance with the creation of agricultural grasslands. Although it is thought that the use of these monogamous fields is relevant to the surrounding landscape. In areas affected by encroaching brush, these cultivated fields are the most suitable nesting habitats available (Coppedge et al. 2001).

**Comparison with Cantle's (1978) Study**

When generally comparing my results to Cantle's (1978) results, some similarities emerge. Cantle had higher density in the newly reclaimed transect than the non-mined control transect for both seasons. I had higher overall density in the reclaimed lands in one season (2003). Cantle found significant differences in nesting guild density between reclaimed and non-mined land. My study also found significant differences in mean/point density between age classes in several nesting guilds. We both had higher overall species diversity on non-mined land (only in Cantle's second breeding season). However, Cantle found higher richness on the non-mined lands, where overall richness was higher in the reclaimed area in my study. The overall diversity and richness of my study on the entire mine and only the reclaimed area was greater than Cantle's overall diversity and richness. This is most likely due to the higher variability in reclamation land age and vegetative successional stages found in my study.

When the two studies were compared, Cantle's (1978) species density was greater than the mean/point density I found for my category 1 age class for both 2003 and 2004. This may have been caused by the difference between our survey methods.

Cantle surveyed four transect lines in the reclaimed area several times throughout each season, whereas I surveyed several points on reclaimed land only during the breeding season and in several different vegetation types. It also may have been that more individuals were present during Cantle's observations. Dickcissels and other declining grassland birds observed on the reclaimed areas may have been more plentiful 30 years prior to my study. Dickcissels are now considered a species of conservation concern which suggests their population is on the decline. Grassland birds in general are declining in numbers (Ingold 2002). Because a majority of areas surveyed in my study were grassland dominated, the declining grassland species numbers may be a factor in explaining my study's lower bird mean/point density when compared to Cantle's study.

The species mean/point diversity of my age-class category 1 was greater than Cantle's (1978) species diversity. This is probably due to the widespread area and different vegetation types in my survey points. Cantle's reclamation area transects were placed in open, pasture vegetation (Cantle 1978). Many of my survey points in age-class category 1 were in pastures, but I also had several points in upland, bottomland, and wetland areas. With more vegetation types included, it is intuitive that I would have a higher mean/point diversity of species.

When comparing my points which were placed on Cantle's (1978) old transects to Cantle's data, the results were not unexpected. On both our non-mined controls, we had a majority of species in the canopy nesting guild. During both studies, the controls were mostly wooded, and it was not surprising to have a majority of canopy nesters. However, my points placed on Cantle's "newest reclaimed" transect were in age-class category 3. Cantle observed a majority of ground nesting species, where I observed a majority of canopy nesting species. This indicates that the area matured in the past 30 years to a later successional stage and therefore supports a different group of bird species.

**Local Vegetation Correlations**

The bird species to vegetation variables correlations presented few surprises. Most bird species were positively correlated with vegetation variables they used for nesting. Mean/point densities of top 10 species in the ground nesting guild were positively correlated with forbs and other grasses which were observed to be high in grasslands. Mean/point densities of species in the ground nesting guild were negatively correlated with woody cover, percent tree canopy cover, number of trees, tree species richness, average tree height, and percent yaupon. All of these vegetative aspects occur in woodlands and are therefore unattractive to ground nesting/grassland species. Yaupon was observed to be an understory shrub in mature woodlands, often forming heavy thickets. Most species that were correlated with percent canopy cover, number of trees, tree species richness, and average tree height also were correlated with percent yaupon. The mean/point densities of the top 10 species in the canopy, cavity, and brush nesting guilds require woodlands and were positively correlated with woody cover, percent tree canopy cover, number of trees, tree species richness, average tree height and percent yaupon.

Only two species' mean/point densities were correlated with percent bare ground (Mourning Dove and European Starling). Huff (2001) also found a positive correlation with Mourning Dove and percent bare ground. He attributed the relationship to doves locate food visually and bare ground areas provide visibility to seeds.

Percent bunchgrass only was correlated with mean/point densities of Dickcissels and Mourning Dove. This is most likely due to these species use of open native grasslands. Although Mourning Dove nest in trees, they will often occur in open areas with scattered trees (Thayer Birding Software 1998). I observed Dickcissels as the only ground nesting top 10 species to frequent native planted grasslands and cultivated pastures. Grasshopper Sparrows and Eastern Meadowlarks were most often seen in Bermudagrass pastures. Bunchgrass often covered the ground in early successional forest land, such as areas with young planted pines or hardwoods. Dickcissels used these young trees for nesting and therefore were correlated with bunchgrass groundcover (Dixon 2004).

Litter depth was often positively correlated with mean/point densities of woodland species and negatively correlated with that of grassland species. I observed that most cultivated pastures had little litter due to hay cutting and grazing. Upland and bottomland forests, however, often had high leaf litter on the ground. One exception was the Dickcissel which had a mean/point density which was positively correlated with litter in 2004 even though it is considered a grassland species and ground nester. This may be due to the Dickcissel’s use of a variety of nesting areas which included native grassland and early seral forests. These areas were not mowed or grazed and therefore accumulated leaf litter from grasses and forbs.

Presence of visual obstructions was positively correlated with the mean/point density of Red-winged Blackbirds and negatively correlated with that of the Tufted Titmouse. Interestingly, this is the only vegetation variable that was correlated with the Red-winged Blackbird. This species is considered a habitat generalist and occurred in all vegetation types except highly wooded areas (Thayer Birding Software 1998). Since this species had no other vegetation relationships, it is unusual for visual obstruction to affect its density. This species was usually observed, however, in fairly open areas with scattered trees for singing perches. The observed need for perches to perform their territorial display may be the cause for this correlation. The negative correlation of the mean/point density of the Tufted Titmouse to visual obstruction indicates this species prefers more open areas for feeding and nesting.

Percent pine cover was correlated only with the mean/point density of the Dickcissel. Dixon (2004) noted the use of pines as a nesting substrate for Dickcissels on Big Brown Mine. I observed that several young pine stands also contained enough open area to allow the growth of grasses and forbs. Pine stands were still sufficiently open for grassland foraging and nesting. Also, most pines were young and less than 2 m in height. Dickcissels are known to nest in small trees such as pines and oaks (Dixon 2004).

Finally, the percent willow bacharris cover was positively correlated with mean/point densities of the Northern Cardinal, White-eyed Vireo, and Bell’s Vireo. The two vireo species are known to prefer thickets and brushland for nesting and foraging (Thayer Birding Software 1998). Willow bacharris is an invasive bushy woody species that creates thickets ideal for these two species.

**Landscape Vegetation Correlations**

*Density.*—No correlations between mean/point bird density and landscape-scale factors were found in 2003. However, during 2004 there was a positive correlation between percent non-mined forest and mean/point bird density. This result contradicts the finding of the previous age class comparison which found mean density to be higher in reclaimed areas in 2003. However, the age class comparison found this to be true only in 2003, with no difference in 2004. The landscape vegetation correlation found no difference in 2003 but a positive correlation of mean/point density with non-mined lands in 2004. The difference in survey years is most likely the source of the contradiction. However there also is the possibility that because the landscape vegetation analysis took into account all vegetation types within the count area of the point instead of just the dominant vegetation type, as with the point analysis, the landscape analysis result may be more accurate. For example, a point that is predominantly a reclaimed area but has a patch of non-mined forest would be better accounted for with the landscape analysis. The landscape analysis accounts for the non-mined patch and attributes some of the point density to this patch. Several small patches of non-mined forest existed on the mine and were most likely accounted for in the landscape analysis, therefore changing the species density relationship with vegetation type.

*Diversity.*—The landscape scale diversity data supported the findings of the age class comparisons and overall and mean/point overall numbers in diversity. In both 2003 and 2004 mean/point diversity had positive correlations with non-mined forest and non-mined pasture and negative correlations with reclaimed forest (2003 only) and reclaimed pasture. Since the age class comparisons found mean/point diversity to be greater in non-mined areas, a positive correlation is indicated, as was found in the landscape vegetation analysis.

There also was a positive correlation of mean/point bird diversity with number of vegetation types and number of vegetation patches. This indicates that the more fragmented an area, the greater the bird diversity. This is intuitive as an area with more vegetation types will attract different types of species (i.e., forestland, grassland) and therefore increase overall diversity. A more fragmented habitat also presents more edges (Laurance and Yensen 1991). Edges are known to attract a higher diversity of species.

*Richness.*—Mean/point species richness correlations were almost identical to the diversity correlations. This is expected as diversity and richness are often a very similar measure. The mean/point richness correlations concur with the mean overall results and the age class comparison results, where mean/point richness is greater (or positively correlated) in non-mined areas.

*Nesting guild density.*— The mean/point density of the aquatic nesting guild was not correlated with any of the vegetation variables. This is surprising since I hypothesized distance to the nearest pond and percent of the point area covered by a pond would be important to this nesting guild.

The mean/point density of the brush nesting guild was positively correlated to number of vegetation types and percent non-mined forest in both survey seasons, and number of vegetation patches and reclaimed forest in 2003. Brush nesting species prefer low growing shrubs and thickets for nesting and foraging (Thayer Birding Software

1998). This type of vegetation was observed to occur both on reclaimed forest land with the invasion of willow bacharris and planting of young trees, and in non-mined forests with thickets of understory yaupon. Number of vegetation types and patches both indicate a high amount of edges in the area. Shrubs and thick brush was often observed to grow on the edge of a forest or fencerow, providing ideal habitat for these species. Brush nesting species were negatively correlated with percent reclaimed pasture (2003 and 2004). Reclaimed pastures were often mowed or grazed with little, if any, woody species. Such lands are not conducive to species needing brush for nesting.

The mean/point density of the canopy nesting guild had a positive correlation with number of vegetation patches, percent non-mined forest, and percent non-mined pasture in 2003 and 2004 and with number of vegetation types in 2004. This guild was negatively correlated with percent reclaimed pasture in both years. This reflects the need for mature trees. Mature trees provide the height and canopy cover needed for nesting. Non-mined forests consisted of several mature trees with large canopy cover. Although non-mined pastures were open and consisted mainly of grasses, several scattered mature trees often were found in these areas. Birds such as the Scissor-tailed Flycatcher and Mourning Dove are canopy nesters but prefer more open habitats for foraging (Thayer Birding Software 1998). Older pastures with mature trees are ideal for canopy nesting species. The reclaimed pastures, however, had few, if any, trees, or the trees present on reclaimed pastures were too small for canopy nesting species.

The mean/point density of the cavity nesting guild had no correlations in 2003 but were positively correlated with number of vegetation types, number of vegetation patches, and percent non-mined forest in 2004. This guild had a negative correlation with percent reclaimed pasture. All correlations support the need of these species for mature woody species such as found on non-mined forests. Reclaimed pasture had little or no woody species for these species to use. Rumble and Gobeille (2003) also found abundance of birds in the cavity nesting guild to be higher in late seral stages of cottonwood forest.

The mean/point density of the colonial nesting guild had a positive correlation with percent reclaimed pasture (2003 and 2004). This guild had a negative correlation with number of vegetation patches (2003) and percent non-mined forest and distance to the nearest pond (2004). As this guild was composed mainly of egrets, herons, and swallows, open pasture provided ideal habitat for foraging and nesting of these species. Their need for continuous, non-fragmented open grassland is displayed in both the positive and negative correlations. The negative correlation with the distance to the nearest pond reflects these species need for water for foraging and nesting (Thayer Birding Software 1998). As the distance from the pond increased, the density of this guild decreased.

The mean/point density of the ground nesting guild had the highest number of correlations. The mean/point density of this guild was positively correlated with percent reclaimed pasture (2003 and 2004) and percent reclaimed forest (2003). Negative correlations include number of vegetation types, number of vegetation patches, percent non-mined forest, percent non-mined pasture (2003 and 2004), percent pond (2004), and distance to the nearest pond (2003). I previously discussed the need for open grasslands for the ground nesting species. Grassland species generally exhibit a negative association with woody vegetation gradients (Coppeddge et al. 2001). Fragmentation of grasslands has a negative impact on most grassland species. This is reflected in the negative correlation with number of vegetation types and patches. I also observed that most non-mined pastures were small in size and highly fragmented. This may explain the negative correlation with this vegetation type. Area and patch size are important determinants for suitable habitat for grassland birds. The large size of reclaimed grasslands with little fragmentation presents a great advantage to attracting grassland birds (DeVault et al. 2002). The negative correlation with ponds reflects the use of upland grasslands by these birds. The species of the ground nesting guild considered in my study do not need a wetland habitat (Thayer Birding Software 1998).

Overall the landscape vegetation correlations agree with the results of the nesting guild mean/point density age class and vegetation type comparisons. For example, guilds that had higher mean densities in the reclaimed areas in the age class comparisons, had a mean/point density positively correlated with percent reclaimed land in the point area in the landscape vegetation correlations. Such a result is evident when looking at the ground nesting guild, for example. The landscape vegetation correlations of mean/point density among nesting guilds display that different nesting guilds were positively associated with either non-mined lands or reclaimed lands in the same vegetation type, not both. For example, mean/point densities of ground nesting species were positively correlated with percent reclaimed pasture and percent reclaimed forest and negatively correlated with percent non-mined pasture and percent non-mined forest.

Some other group of species must therefore inhabit the non-mined pasture and forest. The mean/point density of the cavity nesting guild was positively correlated with percent non-mined forest and negatively correlated with percent reclaimed pasture. Therefore some other species, namely the ground nesters, must inhabit the reclaimed pasture. Different species occur in different nesting guilds. Since different nesting guilds predominantly occur in only non-mined lands or reclaimed lands in one vegetation type, different species must dominate non-mined lands and reclaimed lands.

# CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

Bird density relationships with reclaimed and non-mined land proved to be inconclusive. Overall the data indicated, through several different forms of analysis, that reclaimed land had lower mean/point species diversity than non-mined land. Cantle (1978) also found this to be true over 25 years ago. Overall bird species richness was greater in reclaimed areas than non-mined areas when looking at the area as a whole. However, when studying mean/point species richness, non-mined areas had the higher value. Different nesting guilds, containing different species, dominated different aged reclaimed and non-mined land. Because the goal of many conservation plans emphasizes diversifying species, it is important to diversify land age and vegetative successional stage through disturbance (mining and reclamation).

It also is important to consider the types of species attracted to the different types of lands. Because much of the non-mined land is mature forest and much of the reclaimed land is grassland or young shrub and forest lands, different nesting guilds are attracted to each. Since most surrounding lands are undisturbed forests, the reclaimed mine area provides a refuge large enough to support viable populations of grassland birds and other species dependent on disturbance to return land to an early successional stage. With different species using the reclaimed lands than the non-mined lands the diversity and richness over the area as a whole may increase. In this way, the reclaimed lands seem beneficial to the area. Disturbance created types of vegetation adjacent to sizable tracts of undisturbed land attract new species while still leaving a place for the "native" species.

Another factor to consider is the individual species present on the non-mined and reclaimed lands, with special consideration to species of conservation concern. Five species of conservation concern were observed on Big Brown Mine during the avian counts. They were the American Redstart, Bell's Vireo, Dickcissel, Painted Bunting, and Wood Stork. All of these species occurred in the reclaimed lands. The American Redstart, Bell's Vireo, and Wood Stork were observed exclusively in the reclaimed lands. The large majority of Dickcissels were observed in reclaimed areas as well. The Painted Bunting was the only species of concern that occurred mainly on non-mined lands, though it still occurred in healthy numbers in the reclaimed lands. When considering the choice of returning lands to their non-mined state or keeping some lands in an early successional stage, as the reclaimed lands represent, species' importance for conservation should be ranked. I believe some of the more common species such as Northern Cardinal and Carolina Wren, which occurred in majority in the non-mined lands, can withstand a reduction in numbers to accommodate some of the species of concern using the reclaimed lands.

One follow-up study from this research would be to observe nesting success of grassland species, such as Grasshopper Sparrow and Eastern Meadowlark, which occurred in high numbers in the Bermudagrass pastures. With hay pasture mowing and cattle grazing, I hypothesize the nesting success to be low in these areas. Nevertheless, these species seem to be using the hay pastures for setting territories and nesting in high numbers. Their behavior should be observed to study what may possibly be done to improve nesting success if needed, especially because these species are declining around the country.

**Management Recommendations**

Based on the results of this study and considering other factors of importance the following are recommendations to manage for avian species on Big Brown Mine:

1. Maintain reclaimed lands in different successional stages and preserve some larger tracts of non-mined lands. This should increase overall species diversity and richness because of the different species attracted to the different aged lands. Manage reclaimed lands to sustain species of conservation concern.
2. Maintain open grasslands and dense shrub patches. Postpone cutting on agricultural hay pastures to allow successful nesting of the several bird species, such as the Dickcissel, Eastern Meadowlark, and Grasshopper Sparrow using the pasture.
3. Educate potential buyers of reclaimed land on the importance of maintaining vegetative and avian diversity on the land. Managing the land for long term is important to promote the welfare of certain bird species. Since much of the TXU land is sold to private landowners after reclamation, it is important to educate the landowner on ways to conserve bird species while using the land to their needs. Such methods may include preserving and fencing off riparian corridors, resting certain pastures from cutting or grazing, and leaving patches of undisturbed forest and shrublands.

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## APPENDIX A

List of all species observed during the study, abbreviation used in tables in the text, their nesting guild classification, the age classes and vegetation types in which the species was observed, and the number observed over both 2003 and 2004, on the Big Brown Mine, Freestone County, Texas.

| Common name | Scientific name | Abbreviation | Nesting guild | Age classes | Vegetation types | Number observed | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2003 | 2004 | Total |
| Acadian Flycatcher | *Empidonax virescens* | ACFC | canopy | 3 | UL | 0 | 1 | 1 |
| American Coot | *Fulica americana* | AMCO | aquatic | 1, 2 | WL | 1 | 14 | 15 |
| American Crow | *Corvus brachyrhynchos* | AMCR | canopy | NM, 1, 2, 3 | BL, P, UL, WL | 46 | 27 | 73 |
| American Redstart | *Setophaga ruticilla* | AMRS | canopy | 1, 3 | BL, UL | 0 | 2 | 2 |
| Baltimore Oriole | *Icterus bullockii* | BAOR | migrant | NM | BL | 1 | 0 | 1 |
| Barn Owl | *Tyto alba* | BAOW | cavity | NM | BL | 1 | 0 | 1 |
| Barn Swallow | *Hirundo rustica* | BASW | colonial | NM, 1, 2, 3 | BL, P, UL, WL | 64 | 60 | 124 |
| Bell's Vireo | *Vireo bellii* | BEVI | brush | 1, 2, 3 | BL, P, UL, WL | 15 | 7 | 22 |
| Belted Kingfisher | *Ceryle alcyon* | BEKI | cavity | NM, 2, 3 | BL, P, UL, WL | 4 | 1 | 5 |
| Black Vulture | *Coragyps atratus* | BLVU | ground | NM | P, UL | 1 | 11 | 12 |
| Black-and-white Warbler | *Mniotilta varia* | BWWA | brush | NM | BL | 4 | 2 | 6 |
| Blue Grosbeak | *Guiraca caerulea* | BLGR | brush | NM, 1, 2, 3 | BL, P, UL, WL | 8 | 10 | 18 |
| Blue Jay | *Cyanocitta cristata* | BLJA | canopy | NM, 2, 3 | BL, P, UL, WL | 37 | 70 | 107 |

| Common name | Scientific name | Abbreviation | Nesting guild | Age classes | Vegetation types | Number observed | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2003 | 2004 | Total |
| Blue-gray gnatcatcher | *Polioptila caerulea* | BGGN | canopy | NM, 1, 2, 3 | BL, P, UL, WL | 26 | 11 | 37 |
| Blue-headed vireo | *Vireo solitarius* | BHVI | winter | NM, 1, 3 | BL, UL, WL | 3 | 1 | 4 |
| Blue-winged teal | *Anas discors* | BWTE | aquatic | 1 | UL, WL | 6 | 1 | 7 |
| Brown thrasher | *Toxostoma rufum* | BRTH | brush | NM | BL, P, UL | 5 | 5 | 10 |
| Brown-headed cowbird | *Molothrus ater* | BHCB | parasite | NM, 1, 2, 3 | BL, P, UL, WL | 149 | 102 | 251 |
| Carolina chickadee | *Poecile carolinensis* | CACH | cavity | NM, 1, 2, 3 | BL, P, UL, WL | 84 | 75 | 159 |
| Carolina wren | *Thryothorus ludovicianus* | CAWR | brush | NM, 1, 2, 3 | BL, P, UL, WL | 113 | 89 | 202 |
| Cattle egret | *Bubulcus ibis* | CAEG | colonial | NM, 1, 3 | BL, P, UL, WL | 23 | 67 | 90 |
| Cedar waxwing | *Bombycilla cedrorum* | CEWA | winter | NM, | UL | 0 | 100 | 100 |
| Cliff swallow | *Petrochelidon pyrrhonota* | CLSW | colonial | NM, 1, 2, 3 | BL, P, UL, WL | 155 | 80 | 235 |
| Common grackle | *Quiscalus quiscula* | COGR | canopy | 1, 2, 3 | P, UL, WL | 33 | 1 | 34 |
| Common nighthawk | *Chordeiles minor* | CONH | ground | 1 | UL | 2 | 0 | 2 |
| Common yellowthroat | *Geothlypis trichas* | COYT | brush | 1 | BL | 0 | 1 | 1 |

| Common name | Scientific name | Abbreviation | Nesting guild | Age classes | Vegetation types | Number observed | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2003 | 2004 | Total |
| Crested Caracara | *Caracara plancus* | CRCC | brush | 1 | P | 0 | 1 | 1 |
| Dickcissel | *Spiza americana* | DICK | ground | NM, 1, 2, 3 | BL, P, UL, WL | 489 | 564 | 1017 |
| Double-crested Comorant | *Phalacrocorax auritus* | DCCO | colonial | 3 | WL | 0 | 1 | 1 |
| Downy Woodpecker | *Picoides pubescens* | DOWP | cavity | NM, 1, 2, 3 | BL, P, UL, WL | 23 | 24 | 47 |
| Eastern Bluebird | *Sialia sialis* | EABB | cavity | NM, 2, 3 | BL, P, UL, WL | 4 | 13 | 17 |
| Eastern Kingbird | *Tyrannus tyrannus* | EAKI | canopy | NM, 1, 2, 3 | P, UL, WL | 4 | 3 | 7 |
| Eastern Meadowlark | *Sturnella magna* | EAME | ground | NM, 1, 2, 3 | BL, P, UL, WL | 185 | 138 | 323 |
| Eastern Phoebe | *Sayornis phoebe* | EAPH | canopy | NM, 3 | BL, P, UL, WL | 5 | 2 | 7 |
| Eurasian Collared-dove | *Streptopelia decaocto* | EUCD | canopy | NM | UL | 1 | 0 | 1 |
| European Starling | *Sturnus vulgaris* | EUST | cavity | 3 | P, WL | 150 | 0 | 150 |
| Field Sparrow | *Spizella pusilla* | FISP | winter | NM, 2 | BL, P, UL | 8 | 2 | 10 |
| Grasshopper Sparrow | *Ammodramus savannarum* | GHSP | ground | NM, 1, 2, 3 | BL, P, UL, WL | 115 | 114 | 229 |
| Gray Catbird | *Dumetella carolinensis* | GRCB | brush | 3 | UL | 1 | 0 | 1 |

| Common name | Scientific name | Abbreviation | Nesting guild | Age classes | Vegetation types | Number observed | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2003 | 2004 | Total |
| Great Blue Heron | *Ardea herodias* | GBHE | colonial | 1, 3 | P, UL, WL | 3 | 1 | 4 |
| Great crested Flycatcher | *Myiarchus crinitus* | GCFC | cavity | NM, 2, 3 | BL, P, UL, WL | 1 | 6 | 7 |
| Great Egret | *Ardea alba* | GREG | colonial | 1, 3 | P, WL | 9 | 3 | 12 |
| Greater Yellowlegs | *Trina melanoleuca* | GRYL | winter | 1, 3 | P, UL, WL | 17 | 0 | 17 |
| Great-tailed Grackle | *Quiscalus mexicanus* | GTGR | canopy | 1, 3 | P | 1 | 32 | 33 |
| Green Heron | *Butorides virescens* | GRHE | colonial | NM, 1, 2, 3 | BL, P, UL, WL | 8 | 8 | 16 |
| Hairy Woodpecker | *Picoides villosus* | HAWP | cavity | NM, 2 | BL, UL | 1 | 4 | 5 |
| Henslow's Sparrow | *Ammodramus henslowii* | HESP | ground | Name used in text. Bird not observed in study. | | | | |
| Horned Lark | *Eremophilia alpestris* | HOLA | ground | 1, 2, 3 | P, UL, WL | 23 | 20 | 43 |
| House Sparrow | *Passer domesticus* | HOSP | cavity | 1 | BL | 0 | 2 | 2 |
| Inca Dove | *Columbina inca* | INDO | canopy | 3 | P | 0 | 1 | 1 |
| Indigo Bunting | *Passerina cyanea* | INBU | brush | NM, 2, 3 | BL, P, UL | 15 | 13 | 28 |
| Interior Least Tern | *Sterna antillarum* | INLT | ground | Name used in text. Bird not observed in study. | | | | |
| Killdeer | *Charadrius vociferus* | KIDE | ground | NM, 1, 2, 3 | BL, P, UL, WL | 29 | 22 | 51 |
| Ladder-backed Woodpecker | *Picoides scalaris* | LBWP | cavity | NM, 3 | BL, WL | 0 | 3 | 3 |

| Common name | Scientific name | Abbreviation | Nesting guild | Age classes | Vegetation types | Number observed | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2003 | 2004 | Total |
| Lark Sparrow | *Chondestes grammacus* | LASP | brush | NM, 1, 2, 3 | BL, P, UL, WL | 34 | 24 | 58 |
| Little Blue Heron | *Egretta caerulea* | LBHE | colonial | 1, 3 | WL | 2 | 1 | 3 |
| Loggerhead Shrike | *Lanius ludovicianus* | LOSH | canopy | 3 | P | 0 | 1 | 1 |
| Mallard | *Anas platyrhynchos* | MALL | aquatic | 1 | WL | 1 | 0 | 1 |
| Marsh Wren | *Cistothorus palustris* | MAWR | winter | 1 | WL | 1 | 0 | 1 |
| Mourning Dove | *Zenaida macroura* | MODO | canopy | NM, 1, 2, 3 | BL, P, UL, WL | 166 | 103 | 269 |
| Mourning Warbler | *Oporornis philadelphia* | MOWA | migrant | 3 | UL | 0 | 1 | 1 |
| Northern Bobwhite | *Colinus virginianus* | NOBW | ground | 1, 2 | BL, P, UL, WL | 22 | 8 | 30 |
| Northern Cardinal | *Cardinalis cardinalis* | NOCA | canopy | NM, 1, 2, 3 | BL, P, UL, WL | 284 | 228 | 512 |
| Northern Flicker | *Colaptes auratus* | NOFL | cavity | NM | P | 1 | 0 | 1 |
| Northern Harrier | *Circus cyaneus* | NOHA | winter | 1, 3 | P, WL | 0 | 4 | 4 |
| Northern Mockingbird | *Mimus polyglottos* | NOMO | brush | NM, 1, 2, 3 | BL, P, UL, WL | 89 | 45 | 134 |
| Northern Parula | *Parula americana* | NOPA | canopy | NM | BL | 8 | 7 | 15 |
| Orange-crowned Warbler | *Vermivora celata* | OCWA | winter | NM | UL | 1 | 0 | 1 |

| Common name | Scientific name | Abbreviation | Nesting guild | Age classes | Vegetation types | Number observed | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2003 | 2004 | Total |
| Orchard Oriole | *Icterus spurius* | OROR | canopy | NM, 1, 3 | BL, P, UL, WL | 8 | 7 | 15 |
| Painted Bunting | *Passerina ciris* | PABU | brush | NM, 1, 2, 3 | BL, P, UL, WL | 96 | 98 | 194 |
| Pied-billed Grebe | *Podilymbus podiceps* | PBGR | aquatic | 1, 3 | P, UL, WL | 2 | 4 | 6 |
| Pileated Woodpecker | *Dryocopus pileatus* | PIWP | cavity | NM, 3 | P, UL | 3 | 0 | 3 |
| Pine Warbler | *Dendroica pinus* | PIWA | canopy | 2 | UL | 2 | 1 | 3 |
| Red-bellied Woodpecker | *Melanerpes carolinus* | RBWP | cavity | NM, 1, 3 | BL, P, UL, WL | 35 | 15 | 50 |
| Red-eyed Vireo | *Vireo olivaceus* | REVI | canopy | NM | BL, UL | 1 | 2 | 3 |
| Red-shouldered Hawk | *Buteo lineatus* | RSHA | canopy | NM, 2, 3 | BL, P, UL, WL | 6 | 3 | 9 |
| Red-tailed Hawk | *Buteo jamaicensis* | RTHA | canopy | NM, 1, 2 | BL, P, UL, WL | 4 | 3 | 7 |
| Red-winged Blackbird | *Agelaius phoeniceus* | RWBB | brush | NM, 1, 2, 3 | BL, P, UL, WL | 274 | 329 | 603 |
| Rock Dove | *Columba livia* | RODO | ground | 1 | UL | 10 | 0 | 10 |
| Ruby-crowned Kinglet | *Regulus calendula* | RCKI | canopy | NM, 2, 3 | BL, UL | 4 | 12 | 16 |
| Ruby-throated Hummingbird | *Archilochus colubris* | RTHB | brush | NM, 1, 2, 3 | BL, P, UL | 4 | 7 | 11 |
| Savannah Sparrow | *Passerculus sandwichensis* | SASP | winter | NM, 1, 2, 3 | BL, P, WL | 25 | 51 | 76 |

| Common name | Scientific name | Abbreviation | Nesting guild | Age classes | Vegetation types | Number observed | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | | | | | 2003 | 2004 | Total |
| Scissor-tailed Flycatcher | *Tyrannus forficatus* | STFC | canopy | NM, 1, 2, 3 | BL, P, UL, WL | 122 | 109 | 231 |
| Sedge Wren | *Cistothorus platensis* | SEWR | winter | NM, 2 | BL, P | 1 | 1 | 2 |
| Sharp-shinned Hawk | *Accipiter striatus* | SHSH | winter | 1 | P | 0 | 1 | 1 |
| Snowy Egret | *Egretta thula* | SNEG | colonial | 1 | P, WL, WL | 10 | 2 | 12 |
| Song Sparrow | *Melospiza melodia* | SOSP | winter | NM | BL | 1 | 0 | 1 |
| Summer Tanager | *Piranga rubra* | SUTA | canopy | NM | BL, P, UL | 4 | 4 | 8 |
| Swainson's Hawk | *Buteo swainsoni* | SWHA | canopy | 2 | UL | 0 | 1 | 1 |
| Tufted Titmouse | *Baeolophus bicolor* | TUTI | cavity | NM, 1, 2, 3 | BL, P, UL, WL | 83 | 70 | 153 |
| Turkey Vulture | *Cathartes aura* | TUVU | ground | NM, 1, 2, 3 | BL, P, UL, WL | 17 | 52 | 69 |
| Upland Sandpiper | *Bartramia longicauda* | UPSP | migrant | 1, 2 | P | 14 | 0 | 14 |
| Vesper Sparrow | *Pooecetes gramineus* | VESP | winter | 3 | P | 0 | 2 | 2 |
| Western Kingbird | *Tyrannus verticalis* | WEKI | canopy | NM | P, UL, WL | 8 | 2 | 10 |
| White-crowned Sparrow | *Zonotrichia leucophrys* | WCSP | winter | NM | BL, UL | 0 | 8 | 8 |

| Common name | Scientific name | Abbreviation | Nesting guild | Age classes | Vegetation types | Number observed | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2003 | 2004 | Total |
| White-eyed Vireo | *Vireo griseus* | WEVI | brush | NM, 1, 2, 3 | BL, P, UL, WL | 79 | 68 | 147 |
| White-throated Sparrow | *Zonotrichia albicollis* | WTSP | winter | NM | BL, P, UL | 0 | 21 | 21 |
| Wilson's Warbler | *Wilsonia pusilla* | WIWA | migrant | 1 | BL | 0 | 1 | 1 |
| Wood Stork | *Mycteria americana* | WOST | colonial | 3 | P | 0 | 3 | 3 |
| Yellow Warbler | *Dendroica petechia* | YEWA | migrant | 3 | WL | 0 | 1 | 1 |
| Yellow-billed Cuckoo | *Coccyzus americanus* | YBCU | brush | NM, 1, 2, 3 | BL, P, UL, WL | 60 | 44 | 104 |
| Yellow-breasted Chat | *Icteria virens* | YBCH | brush | NM, 1, 3 | BL, UL | 7 | 4 | 11 |
| Yellow-rumped Warbler | *Dendroica coronata* | YRWA | winter | NM, 2, 3 | BL, UL | 11 | 6 | 17 |
| Yellow-throated Warbler | *Dendroica dominica* | YTWA | canopy | 1, 2, 3 | BL, UL | 1 | 2 | 3 |

## APPENDIX B

List of number of each species seen per age class and vegetation type for 2003 on the Big Brown Mine, Freestone County, Texas.

| Bird spp | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| AMCO | | | | | | | | | | | | | 1 | | | | | | | 1 | | 1 | | | 1 | 1 |
| AMCR | | 2 | | 6 | 1 | 1 | 6 | 14 | | 3 | 5 | 7 | | | 1 | | 8 | 22 | 15 | 1 | 27 | 1 | 6 | 12 | 19 | 46 |
| BAOR | | | | 1 | | | | | | | | | | | | | 1 | | | | 1 | | | | | 1 |
| BAOW | | | | 1 | | | | | | | | | | | | | 1 | | | | 1 | | | | | 1 |
| BASW | | | | | 9 | 8 | 19 | 12 | | | 2 | | 6 | | 8 | | | 48 | 2 | 14 | 12 | 15 | 8 | 29 | 52 | 64 |
| BEVI | 1 | 1 | | | | 2 | | | 8 | | 1 | | 1 | 1 | | | 2 | 2 | 9 | 2 | | 10 | 4 | 1 | 15 | 15 |
| BEKI | | 1 | | 1 | | | 1 | | | | | | | | 1 | | 2 | 1 | | 1 | 1 | | 1 | 2 | 3 | 4 |
| BLVU | | | | | | | | | | | | 1 | | | | | | | 1 | | 1 | | | | | 1 |
| BLWW | | | | 4 | | | | | | | | | | | | | 4 | | | | 4 | | | | | 4 |
| BLGR | | 1 | | | | 1 | 1 | | 3 | | | 1 | 1 | | | | 1 | 2 | 4 | 1 | 1 | 4 | 2 | 1 | 7 | 8 |
| BLJA | | | | 14 | | | 1 | 7 | | | 1 | 14 | | | | | 14 | 8 | 15 | | 35 | | | 2 | 2 | 37 |
| BGGN | | | 1 | 9 | | | 1 | 1 | | 3 | | 9 | 1 | | | 1 | 10 | 2 | 12 | 2 | 20 | 1 | 3 | 2 | 6 | 26 |
| BHVI | | | | 1 | | | | | | | 1 | | 1 | | | | 1 | | 1 | 1 | 1 | 1 | | 1 | 2 | 3 |

| Bird spp | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| BWTE | | | | | | | | | | | | | 6 | | | | | | | 6 | | 6 | | | 6 | 6 |
| BRTH | | | | 2 | | | | 1 | | | | 2 | | | | | 2 | 1 | 2 | | 5 | | | | | 5 |
| BHCB | 6 | 1 | 2 | 59 | 7 | 6 | 5 | 26 | 7 | 9 | 2 | 11 | 3 | | 2 | 3 | 68 | 44 | 29 | 8 | 99 | 23 | 16 | 11 | 50 | 149 |
| CACH | 3 | 3 | 7 | 21 | | 1 | 12 | 14 | | 5 | 1 | 13 | | | 2 | 2 | 34 | 27 | 19 | 4 | 50 | 3 | 9 | 22 | 34 | 84 |
| CAWR | 2 | 4 | 4 | 34 | | 2 | 9 | 13 | | 1 | 3 | 34 | 2 | | 2 | 3 | 44 | 24 | 38 | 7 | 84 | 4 | 7 | 18 | 29 | 113 |
| CAEG | | | 4 | | | | 6 | 9 | | | 4 | | | | | | 4 | 15 | 4 | | 9 | | | 14 | 14 | 23 |
| CLSW | 2 | | | | 19 | 17 | 70 | 7 | 18 | | | | 20 | | 2 | | 2 | 113 | 18 | 22 | 7 | 59 | 17 | 72 | 148 | 155 |
| COGR | | | | | 15 | | 2 | | 1 | | | | 2 | 1 | 12 | | | 17 | 1 | 15 | | 18 | 1 | 14 | 33 | 33 |
| CONH | | | | | | | | | 2 | | | | | | | | | | 2 | | | 2 | | | 2 | 2 |
| DICK | 32 | 12 | 1 | 4 | 96 | 41 | 55 | 6 | 138 | 2 | 11 | 1 | 79 | 8 | 2 | 1 | 49 | 198 | 152 | 90 | 12 | 345 | 63 | 69 | 477 | 489 |
| DOWP | | | | 6 | | 2 | 3 | 4 | | 1 | 1 | 3 | 1 | | 1 | 1 | 6 | 9 | 5 | 3 | 14 | 1 | 3 | 5 | 9 | 23 |
| EABB | | | 1 | 1 | | 1 | | | | | 1 | | | | | | 2 | 1 | 1 | | 1 | | 1 | 2 | 3 | 4 |
| EAKI | | | | | | 1 | | | | | | | 3 | | | | | 1 | | 3 | | 3 | 1 | | 4 | 4 |
| EAME | 1 | 2 | 1 | | 34 | 25 | 74 | 7 | 10 | 4 | 5 | 1 | 3 | | 18 | | 4 | 140 | 20 | 21 | 8 | 48 | 31 | 98 | 177 | 185 |
| EAPH | | | | 2 | | | | 1 | | | | 1 | | | 1 | | 2 | 1 | 1 | 1 | 4 | | | 1 | 1 | 5 |

| Bird spp | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| EUCD | | | | | | | | | | | | 1 | | | | | | | 1 | | 1 | | | | | 1 |
| EUST | | | | | | | 50 | | | | | | | | 100 | | | 50 | | 100 | | | | 150 | 150 | 150 |
| FISP | | | | 1 | | | | 3 | | | | 4 | | | | | 1 | 3 | 4 | | 8 | | | | | 8 |
| GHSP | | | | | 36 | 22 | 30 | 6 | 14 | | | | 5 | | 2 | | | 94 | 14 | 7 | 6 | 55 | 22 | 32 | 109 | 115 |
| GRCB | | | | | | | | | | | 1 | | | | | | | | 1 | | | | | 1 | 1 | 1 |
| GBHE | | | | | | | 1 | | | | 1 | | | | 1 | | | 1 | 1 | 1 | | | | 3 | 3 | 3 |
| GCFC | | | | 1 | | | | | | | | | | | | | 1 | | | | 1 | | | | | 1 |
| GREG | | | | | 1 | | 5 | | | | | | 1 | | 2 | | | 6 | | 3 | | 2 | | 7 | 9 | 9 |
| GRYL | | | | | 1 | | 10 | | 4 | | | | 1 | | 1 | | | 11 | 4 | 2 | | 6 | | 11 | 17 | 17 |
| GTGR | | | | | 1 | | | | | | | | | | | | | 1 | | | | 1 | | | 1 | 1 |
| GRHE | | | | 1 | | 1 | | | | | 1 | 2 | | | 3 | | 1 | 1 | 3 | 3 | 3 | | 1 | 4 | 5 | 8 |
| HAWP | | | | 1 | | | | | | | | | | | | | 1 | | | | 1 | | | | | 1 |
| HOLA | | | | | 11 | 1 | 6 | | 2 | | | | 3 | | | | | 18 | 2 | 3 | | 16 | 1 | 6 | 23 | 23 |
| INBU | | | | 8 | | 2 | | 1 | | 2 | | 2 | | | | | 8 | 3 | 4 | | 11 | | 4 | | 4 | 15 |
| KIDE | | | | | 7 | 2 | 8 | 5 | 4 | | | | 3 | | | | | 22 | 4 | 3 | 5 | 14 | 2 | 8 | 24 | 29 |

| Bird spp | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| LASP | | 1 | 3 | | 8 | 3 | 8 | 1 | 5 | | | 1 | 2 | | 2 | | 4 | 20 | 6 | 4 | 2 | 15 | 4 | 13 | 32 | 34 |
| LBHE | | | | | | | | | | | | | 1 | | 1 | | | | | 2 | | 1 | | 1 | 2 | 2 |
| MALL | | | | | | | | | | | | | 1 | | | | | | | 1 | | 1 | | | 1 | 1 |
| MAWR | | | | | | | | | | | | | 1 | | | | | | | 1 | | 1 | | | 1 | 1 |
| MODO | 11 | 2 | 5 | 13 | 11 | 15 | 19 | 10 | 34 | 7 | 5 | 20 | 8 | 1 | 5 | | 31 | 55 | 66 | 14 | 43 | 64 | 25 | 34 | 123 | 166 |
| NOBW | 2 | | | | 6 | 2 | | | 7 | | | | 5 | | | | 2 | 8 | 7 | 5 | | 20 | 2 | | 22 | 22 |
| NOCA | 10 | 11 | 11 | 67 | 2 | 10 | 19 | 35 | 1 | 15 | 12 | 70 | 5 | | 12 | 4 | 99 | 66 | 98 | 21 | 176 | 18 | 36 | 54 | 108 | 284 |
| NOFL | | | | | | | | 1 | | | | | | | | | | 1 | | | 1 | | | | | 1 |
| NOMO | 1 | 1 | 4 | 1 | 2 | 4 | 38 | 9 | 1 | | 6 | 8 | 1 | | 11 | 2 | 7 | 53 | 15 | 14 | 20 | 5 | 5 | 59 | 69 | 89 |
| NOPA | | | | 8 | | | | | | | | | | | | | 8 | | | | 8 | | | | | 8 |
| OCWA | | | | | | | | | | | | 1 | | | | | | | 1 | | 1 | | | | | 1 |
| OROR | 1 | | 1 | | | | 2 | | | | 1 | | | | 2 | 1 | 2 | 2 | 1 | 3 | 1 | 1 | | 6 | 7 | 8 |
| PABU | 2 | 4 | 1 | 20 | | 7 | 10 | 10 | 8 | 6 | 8 | 13 | 1 | | 5 | 1 | 27 | 27 | 35 | 7 | 44 | 11 | 17 | 24 | 52 | 96 |
| PBGR | | | | | | | | | 1 | | | | 1 | | | | | | 1 | 1 | | 2 | | | 2 | 2 |
| PIWP | | | | | | | 1 | 1 | | | | 1 | | | | | | 2 | 1 | | 2 | | | 1 | 1 | 3 |

| Bird spp | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| PIWA | | | | | | | | | | 2 | | | | | | | | | 2 | | | | 2 | | 2 | 2 |
| RBWP | 1 | | 1 | 12 | | | 4 | 3 | | | | 10 | 3 | | 1 | | 14 | 7 | 10 | 4 | 25 | 4 | | 6 | 10 | 35 |
| REVI | | | | | | | | | | | | 1 | | | | | | | 1 | | 1 | | | | | 1 |
| RSHA | | | | 1 | | 2 | | 2 | | 1 | | | | | | | 1 | 4 | 1 | | 3 | | 3 | | 3 | 6 |
| RTHA | | | | | | | | 1 | | 1 | | 2 | | | | | | 1 | 3 | | 3 | | 1 | | 1 | 4 |
| RWBB | 21 | 7 | 2 | 3 | 97 | 23 | 12 | 7 | 40 | 3 | 1 | 5 | 34 | 6 | 4 | 9 | 33 | 139 | 49 | 53 | 24 | 192 | 39 | 19 | 250 | 274 |
| RODO | | | | | | | | | 10 | | | | | | | | | | 10 | | | 10 | | | 10 | 10 |
| RCKI | | | | 3 | | | | | | | | 1 | | | | | 3 | | 1 | | 4 | | | | | 4 |
| RTHB | | 1 | | | | | | | 2 | 1 | | | | | | | 1 | | 3 | | | 2 | 2 | | 4 | 4 |
| SASP | | | | 1 | | 20 | | 4 | | | | | | | | | 1 | 24 | | | 5 | | 20 | | 20 | 25 |
| STFC | 3 | 3 | 7 | | 7 | 14 | 54 | 11 | 5 | 2 | 7 | 3 | | | 6 | | 13 | 86 | 17 | 6 | 14 | 15 | 19 | 74 | 108 | 122 |
| SEWR | | | | | | | | 1 | | | | | | | | | | 1 | | | 1 | | | | | 1 |
| SNEG | | | | | | | | | | | 4 | | | | 6 | | | | 4 | 6 | | | | 10 | 10 | 10 |
| SOSP | | | | 1 | | | | | | | | | | | | | 1 | | | | 1 | | | | | 1 |
| SUTA | | | | 1 | | | | | | | | 3 | | | | | 1 | | 3 | | 4 | | | | | 4 |

| Bird spp | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| TUTI | | | 1 | 21 | | 2 | 7 | 12 | | | 1 | 36 | | | | 3 | 22 | 21 | 37 | 3 | 72 | | 2 | 9 | 11 | 83 |
| TUVU | | | 7 | 1 | | 1 | | 4 | | 1 | | 1 | | | | 2 | 8 | 5 | 2 | 2 | 8 | | 2 | 7 | 9 | 17 |
| UPSP | | | | | 1 | 13 | | | | | | | | | | | | 14 | | | | 1 | 13 | | 14 | 14 |
| WEKI | | | | | | | | 4 | | | | 3 | | | | 1 | | 4 | 3 | 1 | 8 | | | | | 8 |
| WEVI | | | 5 | 33 | | | 5 | 8 | | | 2 | 26 | | | | | 38 | 13 | 28 | | 67 | | | 12 | 12 | 79 |
| YBCU | 4 | 2 | | 13 | | | 5 | 8 | | 2 | 4 | 17 | 1 | | 3 | 1 | 19 | 13 | 23 | 5 | 39 | 5 | 4 | 12 | 21 | 60 |
| YBCH | 4 | | | 3 | | | | | | | | | | | | | 7 | | | | 3 | 4 | | | 4 | 7 |
| YRWA | | | | 2 | | | | | | 7 | | 2 | | | | | 2 | | 9 | | 4 | | 7 | | 7 | 11 |
| YTWA | | 1 | | | | | | | | | | | | | | | 1 | | | | | | 1 | | 1 | 1 |

# APPENDIX C

List of number of each species seen per age class and vegetation type for 2004 on the Big Brown Mine, Freestone County, Texas.

| Bird spp. | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| ACFC | | | | | | | | | | | 1 | | | | | | | | 1 | | | | | 1 | 1 | 1 |
| AMCO | | | | | | | | | | | | | | 14 | | | | | | 14 | | | 14 | | 14 | 14 |
| AMCR | 2 | | | 3 | | 1 | 6 | 6 | | | 2 | 6 | | | 1 | | 5 | 13 | 8 | 1 | 15 | 2 | 1 | 9 | 12 | 27 |
| AMRS | 1 | | | | | | | | | | 1 | | | | | | 1 | | 1 | | | 1 | | 1 | 2 | 2 |
| BASW | | | 2 | | 4 | 5 | 28 | 11 | | | | | 4 | | 5 | 1 | 2 | 48 | | 10 | 12 | 8 | 5 | 35 | 48 | 60 |
| BEVI | 2 | | | | | | | | 5 | | | | | | | | 2 | | 5 | | | 7 | | | 7 | 7 |
| BEKI | | | | | | | | | | | | 1 | | | | | | | 1 | | 1 | | | | | 1 |
| BLVU | | | | | | | | 8 | | | | 3 | | | | | | 8 | 3 | | 11 | | | | | 11 |
| BWWA | | | | 2 | | | | | | | | | | | | | 2 | | | | 2 | | | | | 2 |
| BLGR | 2 | | | 1 | 1 | 1 | 2 | | 3 | | | | | | | | 3 | 4 | 3 | | 1 | 6 | 1 | 2 | 9 | 10 |
| BLJA | | | | 28 | | 3 | | 13 | | 5 | 1 | 16 | | | | 4 | 28 | 16 | 22 | 4 | 61 | | 8 | 1 | 9 | 70 |
| BGGN | | | 1 | 6 | | | | | | | | 3 | 1 | | | | 7 | | 3 | 1 | 9 | 1 | | 1 | 2 | 11 |
| BHVI | | | | | | | | | | | 1 | | | | | | | | 1 | | | | | 1 | 1 | 1 |

| Bird spp. | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| BWTE | | | | | | | | | 1 | | | | | | | | | | 1 | | | 1 | | | 1 | 1 |
| BRTH | | | | 3 | | | | | | | | 2 | | | | | 3 | | 2 | | 5 | | | | | 5 |
| BHCB | 5 | 5 | 4 | 13 | 1 | 3 | 7 | 21 | 9 | 8 | 9 | 13 | | | 4 | | 27 | 32 | 39 | 4 | 47 | 15 | 16 | 24 | 55 | 102 |
| CACH | 1 | 5 | 7 | 17 | | 1 | 3 | 8 | 1 | | 6 | 19 | 2 | | 4 | 1 | 30 | 12 | 26 | 7 | 45 | 4 | 6 | 20 | 30 | 75 |
| CAWR | 1 | 2 | 4 | 27 | | 1 | 9 | 10 | | 1 | 5 | 26 | 1 | 2 | | | 34 | 20 | 32 | 3 | 63 | 2 | 6 | 18 | 26 | 89 |
| CAEG | | | 8 | | 1 | | 29 | 1 | 6 | | 10 | | 2 | | 10 | | 8 | 31 | 16 | 12 | 1 | 9 | | 57 | 66 | 67 |
| CEWA | | | | | | | | | | | | 100 | | | | | | | 100 | | 100 | | | | | 100 |
| CLSW | 1 | | | | 1 | 42 | 28 | 2 | 2 | 2 | | | | 1 | 1 | | 1 | 73 | 4 | 2 | 2 | 4 | 45 | 29 | 78 | 80 |
| COGR | | | | | | | | | 1 | | | | | | | | | | 1 | | | 1 | | | 1 | 1 |
| COYT | 1 | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | 1 | 1 |
| CRCC | | | | | 1 | | | | | | | | | | | | | 1 | | | | 1 | | | 1 | 1 |
| DICK | 28 | 7 | 4 | 3 | 67 | 63 | 140 | 44 | 110 | 14 | 10 | 5 | 32 | | 26 | 11 | 42 | 314 | 139 | 69 | 63 | 237 | 84 | 180 | 501 | 564 |
| DCCO | | | | | | | | | | | | | | | 1 | | | | | 1 | | | | 1 | 1 | 1 |
| DOWP | 1 | 1 | 3 | 7 | | | 1 | 2 | | 1 | 2 | 6 | | | | | 12 | 3 | 9 | | 15 | 1 | 2 | 6 | 9 | 24 |
| EABB | | | 10 | | | | | 1 | | | 1 | | | | 1 | | 10 | 1 | 1 | 1 | 1 | | | 12 | 12 | 13 |

| Bird spp. | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| EAKI | | | | | | | 1 | | | | | 2 | | | | | | 1 | 2 | | 2 | | | 1 | 1 | 3 |
| EAME | 2 | 1 | 1 | 1 | 29 | 10 | 71 | 2 | 8 | 2 | 4 | | | | 7 | | 5 | 112 | 14 | 7 | 3 | 39 | 13 | 83 | 135 | 138 |
| EAPH | | | | | | | | | | | | 1 | | | 1 | | | | 1 | 1 | 1 | | | 1 | 1 | 2 |
| FISP | | | | | | 1 | | | | | | 1 | | | | | | 1 | 1 | | 1 | | 1 | | 1 | 2 |
| GHSP | | | | 1 | 44 | 20 | 40 | 1 | 1 | 1 | | | 2 | | 4 | | 1 | 105 | 2 | 6 | 2 | 47 | 21 | 44 | 112 | 114 |
| GBHE | | | | | | | | | | | | | 1 | | | | | | | 1 | | 1 | | | 1 | 1 |
| GCFC | | | | 1 | | 1 | 1 | | | | | 2 | | | 1 | | 1 | 2 | 2 | 1 | 3 | | 1 | 2 | 3 | 6 |
| GREG | | | | | | | 1 | | | | | | | | 2 | | | 1 | | 2 | | | | 3 | 3 | 3 |
| GTGR | | | | | | | 31 | | | | | | | | 1 | | | 31 | | 1 | | | | 32 | 32 | 32 |
| GRHE | | | 2 | 1 | | | 2 | | 1 | | | | | | 2 | | 3 | 2 | 1 | 2 | 1 | 1 | | 6 | 7 | 8 |
| HAWP | | 1 | | 1 | | | | | | | | 2 | | | | | 2 | | 2 | | 3 | | 1 | | 1 | 4 |
| HOLA | | | | | 10 | | 2 | | 2 | | | | 6 | | | | | 12 | 2 | 6 | | 18 | | 2 | 20 | 20 |
| HOSP | 2 | | | | | | | | | | | | | | | | 2 | | | | | 2 | | | 2 | 2 |
| INDO | | | | | | | 1 | | | | | | | | | | | 1 | | | | | | 1 | 1 | 1 |
| INBU | | | 2 | 2 | | 1 | | 1 | | 2 | 2 | 3 | | | | | 4 | 2 | 7 | | 6 | | 3 | 4 | 7 | 13 |

| Bird spp. | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| KIDE | | | | 2 | 1 | 3 | 7 | 3 | 2 | | | | | | 4 | | 2 | 14 | 2 | 4 | 5 | 3 | 3 | 11 | 17 | 22 |
| LBWP | | | | 2 | | | | | | | | | | | 1 | | 2 | | | 1 | 2 | | | 1 | 1 | 3 |
| LASP | | | 2 | 2 | 3 | 3 | 2 | 4 | 6 | | | | 2 | | | | 4 | 12 | 6 | 2 | 6 | 11 | 3 | 4 | 18 | 24 |
| LBHE | | | | | | | | | | | | | | | 1 | | | | | 1 | | | | 1 | 1 | 1 |
| LOSH | | | | | | | 1 | | | | | | | | | | | 1 | | | | | | 1 | 1 | 1 |
| MODO | 7 | 4 | 4 | 9 | 9 | 6 | 14 | 10 | 13 | 3 | 3 | 10 | 5 | | 6 | | 24 | 39 | 29 | 11 | 29 | 34 | 13 | 27 | 74 | 103 |
| MOWA | | | | | | | | | | | 1 | | | | | | | | 1 | | | | | 1 | 1 | 1 |
| NOBW | | | | | 1 | 1 | | | 5 | | | | 1 | | | | | 2 | 5 | 1 | | 7 | 1 | | 8 | 8 |
| NOCA | 9 | 8 | 8 | 54 | 1 | 4 | 20 | 26 | 5 | 10 | 15 | 57 | 4 | | 6 | 1 | 79 | 51 | 87 | 11 | 138 | 19 | 22 | 49 | 90 | 228 |
| NOHA | | | | | 1 | | 1 | | | | | | 2 | | | | | 2 | | 2 | | 3 | | 1 | 4 | 4 |
| NOMO | 2 | | 1 | | | 2 | 18 | 8 | 2 | 1 | 3 | 3 | | | 5 | | 3 | 28 | 9 | 5 | 11 | 4 | 3 | 27 | 34 | 45 |
| NOPA | | | | 7 | | | | | | | | | | | | | 7 | | | | 7 | | | | | 7 |
| OROR | | | 1 | | | | 3 | 3 | | | | | | | | | 1 | 6 | | | 3 | | | 4 | 4 | 7 |
| PABU | 4 | 4 | 8 | 3 | | 3 | 13 | 17 | 11 | 7 | 6 | 10 | 5 | | 6 | 1 | 19 | 33 | 34 | 12 | 31 | 20 | 14 | 33 | 67 | 98 |
| PBGR | | | | | 1 | | | | 2 | | | | | | 1 | | | 1 | 2 | 1 | | 3 | | 1 | 4 | 4 |

| Bird spp. | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| PIWA | | | | | | | | | | 1 | | | | | | | | | 1 | | | | 1 | | 1 | 1 |
| RBWP | | | 1 | 5 | | | 1 | 2 | | | | 5 | | | 1 | | 6 | 3 | 5 | 1 | 12 | | | 3 | 3 | 15 |
| REVI | | | | 1 | | | | | | | | 1 | | | | | 1 | | 1 | | 2 | | | | | 2 |
| RSHA | | | | | | | | | | | | 2 | | | 1 | | | | 2 | 1 | 2 | | | 1 | 1 | 3 |
| RTHA | | | | 2 | 1 | | | | | | | | | | | | 2 | 1 | | | 2 | 1 | | | 1 | 3 |
| RWBB | 16 | 15 | 5 | 47 | 42 | 14 | 63 | 38 | 37 | 2 | 9 | | 20 | 5 | 9 | 7 | 83 | 157 | 48 | 41 | 92 | 115 | 36 | 86 | 237 | 329 |
| RCKI | | | | 5 | | | | | | 1 | 1 | 5 | | | | | 5 | | 7 | | 10 | | 1 | 1 | 2 | 12 |
| RTHB | 1 | | | 1 | | | 1 | | 3 | | 1 | | | | | | 2 | 1 | 4 | | 1 | 4 | | 2 | 6 | 7 |
| SASP | | 1 | | | 21 | | 8 | | | | | | 21 | | | | 1 | 29 | | 21 | | 42 | 1 | 8 | 51 | 51 |
| STFC | 4 | | 2 | | 7 | 12 | 41 | 21 | 3 | 2 | 6 | 5 | 1 | | 5 | | 6 | 81 | 16 | 6 | 26 | 15 | 14 | 54 | 83 | 109 |
| SEWR | | 1 | | | | | | | | | | | | | | | 1 | | | | | | 1 | | 1 | 1 |
| SHSH | | | | | 1 | | | | | | | | | | | | | 1 | | | | 1 | | | 1 | 1 |
| SNEG | | | | | 2 | | | | | | | | | | | | | 2 | | | | 2 | | | 2 | 2 |
| SUTA | | | | | | | | 1 | | | | 3 | | | | | | 1 | 3 | | 4 | | | | | 4 |
| SWHA | | | | | | | | | | 1 | | | | | | | | | 1 | | | | 1 | | 1 | 1 |

| Bird spp. | Number counted per category | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL1 | BL2 | BL3 | NMBL | P1 | P2 | P3 | NMP | UL1 | UL2 | UL3 | NMUL | WL1 | WL2 | WL3 | NMWL | BL total | P total | UL total | WL total | NM total | 1 total | 2 total | 3 total | Mined total | Total |
| TUTI | | | | 21 | | 2 | 4 | 6 | | 1 | 1 | 32 | 2 | | | 1 | 21 | 12 | 34 | 3 | 60 | 2 | 3 | 5 | 10 | 70 |
| TUVU | | | 1 | 4 | 2 | 1 | 3 | 3 | 5 | 6 | | 19 | 3 | | | 5 | 5 | 9 | 30 | 8 | 31 | 10 | 7 | 4 | 21 | 52 |
| VESP | | | | | | | 2 | | | | | | | | | | | 2 | | | | | | 2 | 2 | 2 |
| WEKI | | | | | | | | 1 | | | | 1 | | | | | | 1 | 1 | | 2 | | | | | 2 |
| WCSP | | | | 6 | | | | | | | | 2 | | | | | 6 | | 2 | | 8 | | | | | 8 |
| WEVI | 2 | 1 | 2 | 27 | | 1 | 2 | 7 | | 2 | 3 | 20 | 1 | | | | 32 | 10 | 25 | 1 | 54 | 3 | 4 | 7 | 14 | 68 |
| WTSP | | | | 12 | | | | 2 | | | | 7 | | | | | 12 | 2 | 7 | | 21 | | | | | 21 |
| WIWA | 1 | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | 1 | 1 |
| WOST | | | | | | | 3 | | | | | | | | | | | 3 | | | | | | 3 | 3 | 3 |
| YEWA | | | | | | | | | | | | | | | 1 | | | | | 1 | | | | 1 | 1 | 1 |
| YBCU | 3 | 2 | 1 | 5 | 1 | | | 9 | 1 | 3 | 6 | 8 | 3 | | 2 | | 11 | 10 | 18 | 5 | 22 | 8 | 5 | 9 | 22 | 44 |
| YBCH | 2 | | | 1 | | | | | | | 1 | | | | | | 3 | | 1 | | 1 | 2 | | 1 | 3 | 4 |
| YRWA | | 1 | | 3 | | | | | | | 1 | 1 | | | | | 4 | | 2 | | 4 | | 1 | 1 | 2 | 6 |
| YTWA | 1 | | | | | | | | | | 1 | | | | | | 1 | | 1 | | | 1 | | 1 | 2 | 2 |

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